

The background of the cover is a lush, close-up photograph of a plant with vibrant green, heart-shaped leaves and several long, drooping spikes of small yellow flowers. The lighting is bright, highlighting the texture of the leaves and the delicate structure of the flower spikes.

Aquatics

SUMMER 2015

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Chinese tallowtree (see article page 8).
Photo courtesy Stephen Enloe.

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LINKING RESEARCH AND OUTREACH WITH

Successful Invasive Plant Management in Florida

by Don C. Schmitz and Jeffrey D. Schardt

Florida is particularly prone to non-native species invasions. Most of Florida has a climate similar to that of the Neotropics, with an absence of yearly hard freezes, and exhibits a disturbed and diverse patchwork of agricultural, natural area, and urban habitats. The southern half of Florida is a peninsula and habitat island, bounded on three sides by water and the fourth by frost; and like oceanic islands has a relatively impoverished native flora and fauna. Florida also has many lakes, streams, and rivers that facilitate the spread of invasive species. These characteristics have made Florida an epicenter for invasions by both plants and animals. During the past 400 years, Florida has been invaded with periodic influxes of mostly tropical and subtropical non-native plants. Invasions increased during the twentieth century with the rise of the aquarium,

ornamental plant, and exotic pet industries and through unintentional contaminants in imported goods.

Beginning in the 1890s, the floating South American water hyacinth started disrupting logging and steamboat traffic on the St. Johns River. This resulted in authorization of Florida's first invasive plant management program by the 55th Congress through the Rivers and Harbors Act of 1899. This program was administered by the U.S. Army Corps of Engineers (USACE). Despite a half-century of various methods of management, water hyacinth occupied more than 125,000 acres of Florida's public lakes and rivers by the late 1950s. About that time, the submersed aquatic plant hydrilla, native to Southeast Asia, was introduced into Florida's waterways. It rapidly spread throughout the state during the 1970s and 1980s, disrupting recreational use, fisheries, navigation, and flood control.

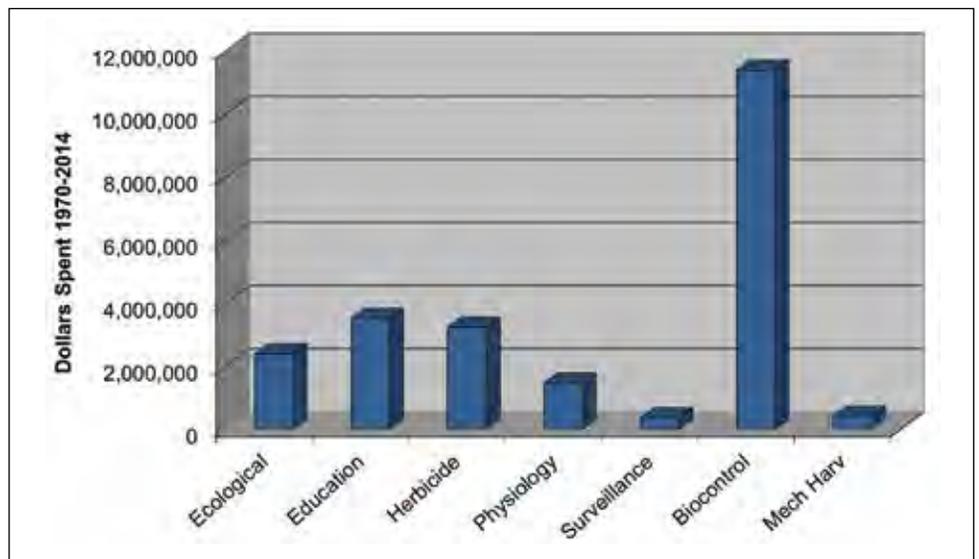


Figure 1. The amount of funds spent for research and outreach by category by the State of Florida from 1970 through 2014. Image courtesy FWC.

Despite extensive control efforts, invasive plant management programs remained fragmented during the 1960s. In 1969, the Florida Legislature enacted laws that provided invasive plant management funding from boat registrations and designated a lead agency to coordinate management and research activities in Florida.

Recognizing that research is the foundation of environmentally and economically sound invasive plant management programs, the State of Florida, through the Department of Natural Resources, made funding available for invasive plant research beginning in 1970 (the invasive plant management program was absorbed by the newly created Department of Environmental Protection in the early 1990s, and in 2008 was transferred into the Florida Fish and Wildlife Conservation Commission). State-funded research has resulted in a large pool of expertise and research infrastructure within Florida's university system and various state and federal agencies. This scientific expertise has in turn attracted other sources of research funding that have improved Florida's invasive plant management programs. For example, the management of invasive plants in Florida has been greatly aided by research funded and conducted by the USACE and the U.S. Department of Agriculture's Agricultural Research Service (USDA-ARS).

The focus of Florida's invasive plant management research program in the 1970s and 1980s was to reduce dependence on aquatic herbicides because of public concern about pesticide use, especially in water. State research funding during the 1970s focused on biological control methods using insects and plant pathogens on water hyacinth, along with grass carp, mechanical control, and water level fluctuation for hydrilla control. Biological control research was pioneered by the USACE in the 1960s with the release of the alligatorweed flea beetle that successfully controlled alligatorweed in Florida. The state later became the main funding source for biological control efforts that resulted in the release of more than twenty insect species that target eight widespread invasive plant species in Florida. Between 1970 and 2014, the State of Florida funded

57 biological control research projects at a cost of \$11.3 million (Figure 1). Biocontrol research funds were augmented by additional monies from other state and federal agencies. However, none of the biological control releases produced immediate or effective resource invasive plant management results, especially important in flood control and navigation systems; therefore, the state continued to rely on aquatic-registered herbicides to meet management needs.

During the 1980s, invasive plant management research in Florida shifted toward developing second-generation aquatic herbicides such as fluridone and glyphosate that have low toxicities to fish and invertebrates and are relatively selective in controlling invasive plants among non-target plant communities. Fluridone was found to be particularly effective in controlling hydrilla and its regrowth from subterranean tubers for up to 1.5 to 2 years after a single application. In addition, almost \$1 million was spent at this time on basic research at Florida's universities to improve understanding of invasive plant growth requirements, seasonal population dynamics, and environmental impacts. Knowledge gained from this research allowed for more effective hydrilla and water hyacinth maintenance control programs in Florida's waterways during the 1980s. Maintenance control, or maintaining invasive plant populations at their lowest feasible levels, was achieved for water

hyacinth by the late 1980s, reducing the statewide population to between 3,000 and 5,000 acres at any time during the year (Figure 2). More than \$9 million was spent on state-funded research on hydrilla and water hyacinth from 1970 through 2014 (Figure 3).

Florida's invasive plant research priorities increasingly included wetland and terrestrial species during the 1990s, with the implementation of the state's invasive upland plant management program. The state began supporting biological control research on melaleuca (1994), Brazilian pepper (1999), Old World climbing fern (2000), Chinese tallow (2002), and air potato (2003). Since 1997, this research has resulted in the release of several insect species from Australia that attack melaleuca, including a weevil that is reducing fruit and seed production and affecting recruitment, invasion potential, and population abundance. A leaf-feeding beetle from Asia was discovered in Nepal by scientists from the USDA-ARS and released in Florida to control air potato in 2011. Beetle survival and establishment have been demonstrated at several release sites, resulting in reduced height of vines and decreased bulbil production. Additional biological control agents are expected to be released during the next several years targeting water hyacinth, water lettuce, air potato, Brazilian pepper, Chinese tallow, and Old World climbing fern.

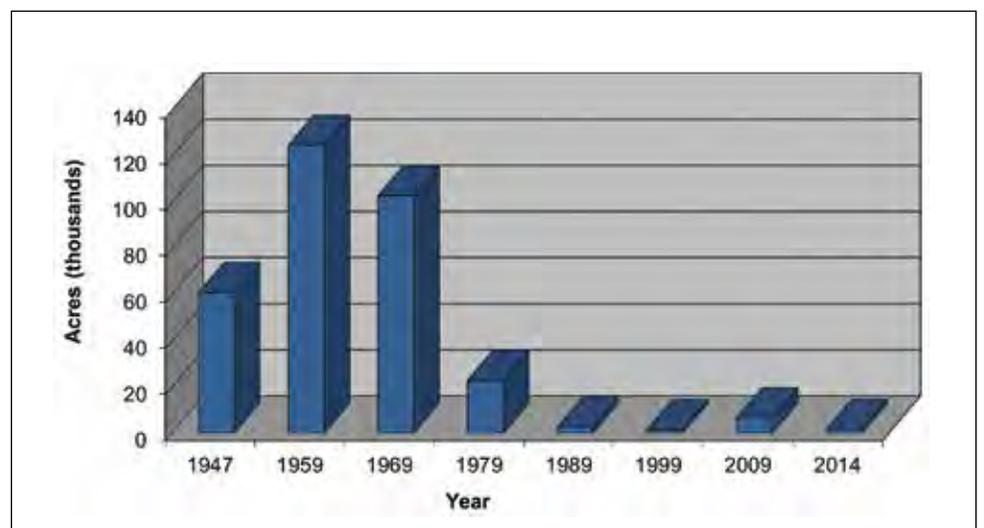


Figure 2. Acres of water hyacinth estimated in Florida public lakes and rivers - 1947-2014. Image courtesy FWC.

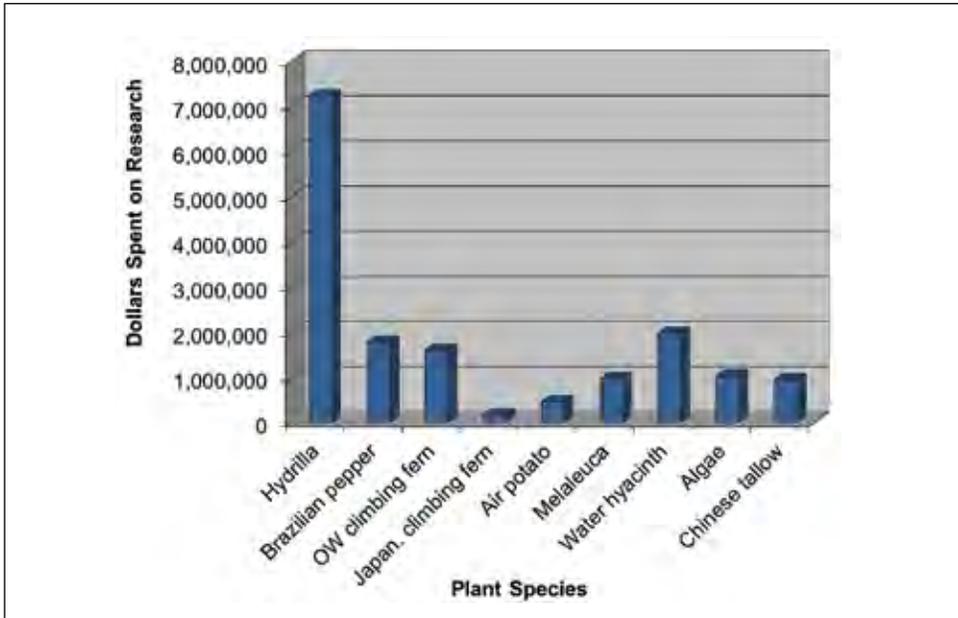


Figure 3. The amount of funds spent on nine species of plants by the State of Florida from 1970 through 2014. Image courtesy FWC.

In 2000, research confirmed that standard application rates and exposure periods for fluridone, the primary aquatic herbicide used for large-scale hydrilla management in Florida public lakes and rivers, were not providing previously achieved long-term control – in some cases, little control at all. This result was surprising because hydrilla reproduces vegetatively in Florida (only female plants are present), so there is no avenue for gene recombination. Repeated low concentrations of fluridone may have removed highly susceptible plants or clones and left more tolerant ones. In the absence of viable large-scale management technology, fluridone-tolerant hydrilla populations could expand on a regional scale with the potential for millions of dollars in damage from flooding, loss of recreational opportunities, and waterway degradation.

In 2002, the state’s research program shifted priorities and funding to find other management technologies and strategies for hydrilla control. Few options existed for large-scale hydrilla control. Besides fluridone, which had been registered for use in Florida waters in 1986, the only other available herbicides with hydrilla control activity were copper, diquat, and endothall. All had been registered prior to the early 1960s and used for small-scale

hydrilla management, but none had been applied at a large scale. Many herbicides that had been used for aquatic plant control through the early 1970s were no longer available by the late 1990s; they were either withdrawn from the market by the registrant or failed to meet new U.S. Environmental Protection Agency (EPA) registration requirements. In 2000, only six herbicide compounds remained registered for aquatic plant control in Florida waters.

Researchers at the University of Florida (UF) and USACE convened a summit among industry, resource managers, and EPA representatives to evaluate herbicides with aquatic plant control activity and to expedite the registration process to develop new strategies to control Florida invasive aquatic plants, especially hydrilla. The state contributed funding to the research to screen candidate herbicides for aquatic registration and to evaluate efficacy and selectivity of compounds that met EPA and Florida Department of Agriculture and Consumer Services approval for use in Florida waters. A total of \$2.3 million was spent on herbicide research targeting hydrilla from 1970 through 2015, with the majority spent between 2002 and 2015.

The increased research and operational evaluation effort led to registration of an additional nine herbicide compounds for

use in Florida waters since 2003. In 2015, sixteen herbicide compounds in 29 formulations and more than 90 trade names are available to Florida aquatic plant managers. Eleven of the 16 compounds and 22 of the 29 formulations have activity on hydrilla and thus provide many choices and combinations of herbicides for cost-effective and selective hydrilla control at any management scale faced by aquatic resource managers. This, in addition to a better understanding of hydrilla physiology and the roles that various environmental conditions play in hydrilla growth and control, has allowed managers to suppress hydrilla growth in public lakes and rivers to levels recorded in the early 1980s – prior to hydrilla expansion in Florida. There has also been a concurrent reduction in control costs and herbicide use with the statewide reduction in hydrilla populations (Figure 4).

For Old World climbing fern, more than \$1.6 has been spent since 2000 to determine optimal management strategies to control this invasive plant. Both field testing of herbicides and biological control research were funded to find a selective means to reduce or remove this plant’s ability to form dense canopies without harming native plant species. Several biological control agents have been released with mixed results to date. The state will continue to fund research to find additional host-specific biological control agents to reduce Old World climbing fern because of the ecological harm this plant species can cause. This non-native climbing fern can completely engulf Everglade tree islands, pinelands, and cypress swamps and kill mature native trees along with their associated epiphytic orchids and bromeliads. It can also smother understory vegetation, preventing regeneration of native plant communities. In addition, it can create hotter fires and act as a fire ladder into native tree canopies where fire normally does not reach, killing these typically fire-tolerant species.

During its 45-year existence, the State of Florida invasive plant management program has contracted over 200 scientific research projects at a cumulative cost of \$24.5 million to find more cost-effective

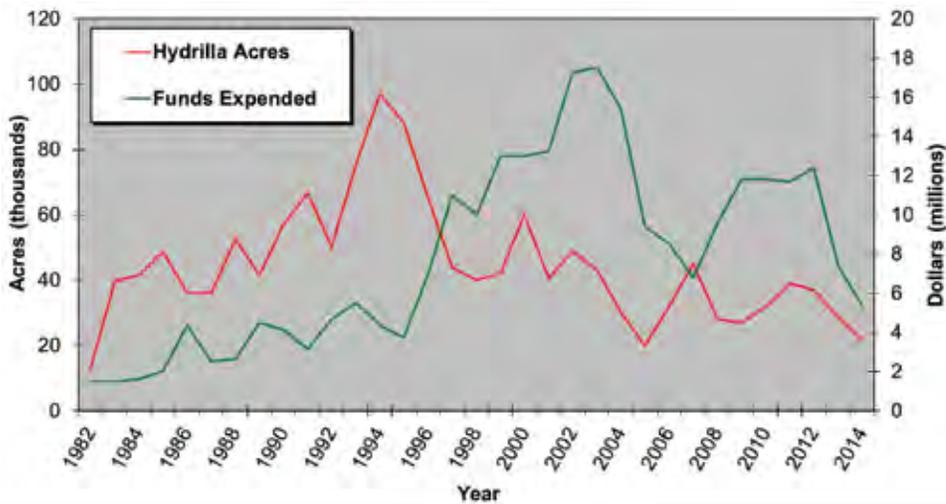


Figure 4. Acres of hydrilla (left axis) estimated in Florida public lakes and rivers and dollars spent controlling hydrilla (right axis) from 1982-2014. Image courtesy FWC.

and environmentally compatible means of controlling invasive plant populations on public conservation lands and waterways. Almost half of the research funding has been spent on biological control research (see Figure 1). Due to new plant introductions, changes in water uses, and shifts in plant populations, research must continue in order to manage Florida's public waterways and conservation lands. Given the present lack of federal and state regulations for pre-screening imported plant species for invasiveness, we can expect new plant invaders in Florida conservation lands and waterways. Also, additional herbicide resistance issues are likely to arise despite our best efforts at herbicide stewardship. Florida is the only state to have developed an extensive research infrastructure along with a network of scientists specialized in invasive plant management research. Other states, and often other countries, call on Florida researchers for their management expertise. It should be noted that more than \$555 million has been spent in Florida by state and federal agencies since 1980 to control aquatic, wetland, and upland plants on publicly owned waterways (\$427 million) and conservation lands (\$129 million). The total research funds spent by the State since 1970 comprise less than 5% of the amount of invasive plant control funds spent.

Along with scientific research, the State of Florida has spent approximately \$3.7 million funding education and outreach, primarily on projects developed and

implemented at UF. These efforts have increased public awareness about invasive plant species by developing informational materials for stakeholders and resource managers, classroom curricula and activities for all school levels, and maintaining a comprehensive library and website addressing all phases of aquatic plant management in Florida. In addition, the world's largest database for aquatic and wetland plants (the Aquatic Plant Information Retrieval System or APIRS) was established to collect and disseminate diverse types of scientific literature on invasive plant management.

In summary, following are some of the lessons we learned from funding Florida's invasive plant management research program through the years.

For herbicide research:

1. Herbicides must be cost-effective at controlling the target plant species or they will not be extensively used.
2. New herbicides and herbicide combinations must be selective in conserving or enhancing native vegetation.
3. Not all herbicides are created equal (see 1 and 2).

For biological control (biocontrol) research:

1. Host specificity is essential for governmental approval and eventual release of agents.

2. Once released, biocontrol agents may suppress invasive plant populations but will not eradicate them.
3. Multiple biocontrol agent releases are likely needed to suppress an invasive plant species.
4. Assessment of potential biocontrol agents is a long-term and expensive research commitment.
5. When successful, biological control agents can reduce long-term invasive plant management costs.

For outreach and education:

1. Presenting a clear overall invasive plant management message is essential.
2. All education and outreach tools that are available must be used; these include targeted workshops (PLANT CAMP and Lakeville – see *Aquatics*, Winter, 2014), demonstration projects (see *Aquatics*, Fall 2012), websites (see *Plant Management in Florida Waters – An Integrated Approach* at plants.ifas.ufl.edu/manage/), and use of social media.
3. Outreach efforts must be multi-generational because invasive plant management will continue indefinitely.
4. Dedicated, professional staff, trained in all aspects of outreach and education, are crucial to inform the public about the importance of managing Florida's invasive plant populations because few people remember what Florida's waterways and conservation lands were like before modern invasive plant management strategies and techniques were employed. View *A Photo History of Florida Steamboats and Water Hyacinth Management* at <http://plants.ifas.ufl.edu/manage/why-manage-plants/a-photo-history-of-florida-steamboats-and-water-hyacinth-management>

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Chinese tallowtree: emerging tools for an old foe

by Stephen Enloe and Nancy Loewenstein

Ben Franklin once called it, “A most useful plant.” Its benefits have been touted over time for oilseed production, beekeeping, and bioenergy. But in most cases, the risks and negative impacts of Chinese tallowtree (*Triadica sebifera*) far outweigh the rewards, and this well-known invasive tree continues to wreak havoc in wetlands across the entire southeastern United States, from Texas to North Carolina.

Chinese tallowtree is a single or multi-stemmed deciduous tree up to 50 feet in height. Leaves are alternate, broadly ovate with rounded bases, tips that taper to a point, and entire margins. Small yellow flowers are borne on spikes up to eight inches in length in the spring and are very attractive to many insects, including honeybees. The fruit is a three-lobed capsule and the seeds are covered in a waxy white coating. The fruit ripen from late summer through fall and the capsules open, revealing the bright white seed inside. This has resulted in another widely used common name, “popcorn tree.” Tallowtree has historically been popular as an ornamental due to its rapid growth, resistance to pests, unique fruits, and brilliant fall colors. However, it is now classified as a

noxious weed by the Florida Department of Agriculture and Consumer Sciences, which prohibits its sale or movement within the State.

Tallowtree possesses many characteristics that promote its success as an invasive tree. Seed are widely dispersed by birds and small mammals.

Tallowtree seed also float and may move by water throughout riparian areas subject to flooding. It grows rapidly and produces numerous seed from an early age; a mature tree can produce upwards of 100,000 seeds. Seedlings and saplings tolerate the shady conditions of many closed-canopy riparian forests. When a gap forms through natural or anthropogenic means, its rapid growth rates put it ahead of most other woody species. Tallowtree is also a prolific sprouter from cut or damaged stems and shallow lateral roots. Many managers have made the mistake of cutting it with no follow-up treatment, and the result is a dramatic increase in tallowtree stem numbers and biomass. These inherent characteristics can result in what is best described in modern lingo as “extreme makeover, ecosystem edition.” Tallowtree is notorious for converting wet prairies to dense tallowtree forests and few other species persist beneath it.





Figure 2. Fruit and seeds of Chinese tallowtree. Photo courtesy Stephen Enloe.

Over the last twenty years, tallowtree management has largely been herbicide-driven, as no other effective tools have been developed for landscape-scale management. In Florida, triclopyr has been the most widely used herbicide, with treatments developed for foliar, cut stump, injection, and basal bark application methods. Triclopyr has generally provided good tallowtree control with these techniques. However, sprouting from stumps and lateral roots following triclopyr treatment has routinely plagued managers, resulting in the need to retreat previously treated individuals. This type of lateral root sprouting is common in the invasive plant world and other problem species known for this include tree of heaven (*Ailanthus altissima*), Chinese privet (*Ligustrum sinense*), and saltcedar (*Tamarix* spp.).

Despite the spread and growing impact of tallowtree over the last 20 years,

relatively few published studies have evaluated tools for control. Most quoted sources for tallowtree control are in the grey literature and have no hard data to support the recommendations. Several herbicides, including imazamox, aminopyralid, aminocyclopyrachlor, and fluroxypyr, have recently been registered for use in either aquatic (imazamox) or seasonally dry (aminopyralid, aminocyclopyrachlor, fluroxypyr) wetlands. Given the need to increase available tools for tallowtree control, these newly registered products warrant testing. Therefore, our objective was to evaluate these chemistries for use with multiple treatment methods, including foliar, cut stump, and basal bark treatment.

We established three study sites, near Montgomery and Wetumpka, Alabama and Pineville, Louisiana. Two of the sites were seasonally wet pastures and the other was a bottomland hardwood site on the

Tallapoosa River. At each site, cut stump, foliar, and basal bark experiments were conducted from December 2010 until October 2012. Cut stump and basal bark treatments were applied in December 2010. For cut stump treatments, individual trees were cut with a chainsaw and herbicide treatments were immediately applied directly to the entire exposed cambium layer of each stump. Basal bark herbicide treatments were mixed with an oil carrier (Bark Oil Blue) and applied to the entire circumference of the bottom twelve inches of each stem. Ground line diameter of stems used in the basal bark treatments did not exceed 6 inches. Foliar treatments were applied in June 2011 to fully leafed-out regrowth approximately 50 inches tall from stumps that were cut but not treated the previous January. Data were collected for two growing seasons following treatment and included tallowtree foliar cover and number and height of new stump



Figure 3. Extreme makeover, ecosystem edition, in progress. Photo courtesy Stephen Enloe.



sprouts and lateral root sprouts found within a one-meter radius of each stem.

In the cut stump study, untreated stumps sprouted wildly and averaged over 18 new sprouts per stump 21 months after treatment (Figure 4, left). All herbicide treatments were very effective in preventing stump sprouting compared to the untreated control and few new sprouts were observed growing from any treated stumps. This is consistent with past experiences of many land managers. However, lateral root sprout numbers varied significantly between herbicide treatments and the untreated control. Milestone (aminopyralid) decreased lateral root sprouting compared to the untreated control and was similar to Vista XRT (fluroxypyr). Garlon 3A (triclopyr) and Clearcast (imazamox) both resulted in an increase in lateral root sprouting compared to the untreated control. This type of increase in lateral root sprouting is often described by practitioners as “doing something that makes the tree angry such that it grows back with a vengeance”.

We also calculated % mortality, which we defined as the percent of treated trees that had zero new stump sprouts and zero new lateral root sprouts 21 months after treatment. Milestone and Vista XRT resulted in 68 and 51% mortality, respectively, and were not significantly different from one another (Figure 4, right). Clearcast and Garlon 3A resulted in 22 and 11% mortality, respectively, and were also not different from one another.

In the basal bark study, aminocyclopyrachlor, Vista XRT and Garlon 4 were very effective at stopping new sprouts from the root collar of the treated stems. However, the herbicides again varied in their effect on lateral root sprouting. Aminocyclopyrachlor and Vista XRT nearly eliminated lateral root sprouting, while Garlon 4 greatly increased lateral root sprouting (Figure 5, left). This was also reflected in the mortality data; aminocyclopyrachlor and Vista XRT resulted in 86 and 72% mortality, while Garlon 4 resulted in 26% mortality (Figure 5, right).

In the foliar treatment study, stump and lateral sprouting were somewhat variable (data not shown), while foliar cover data

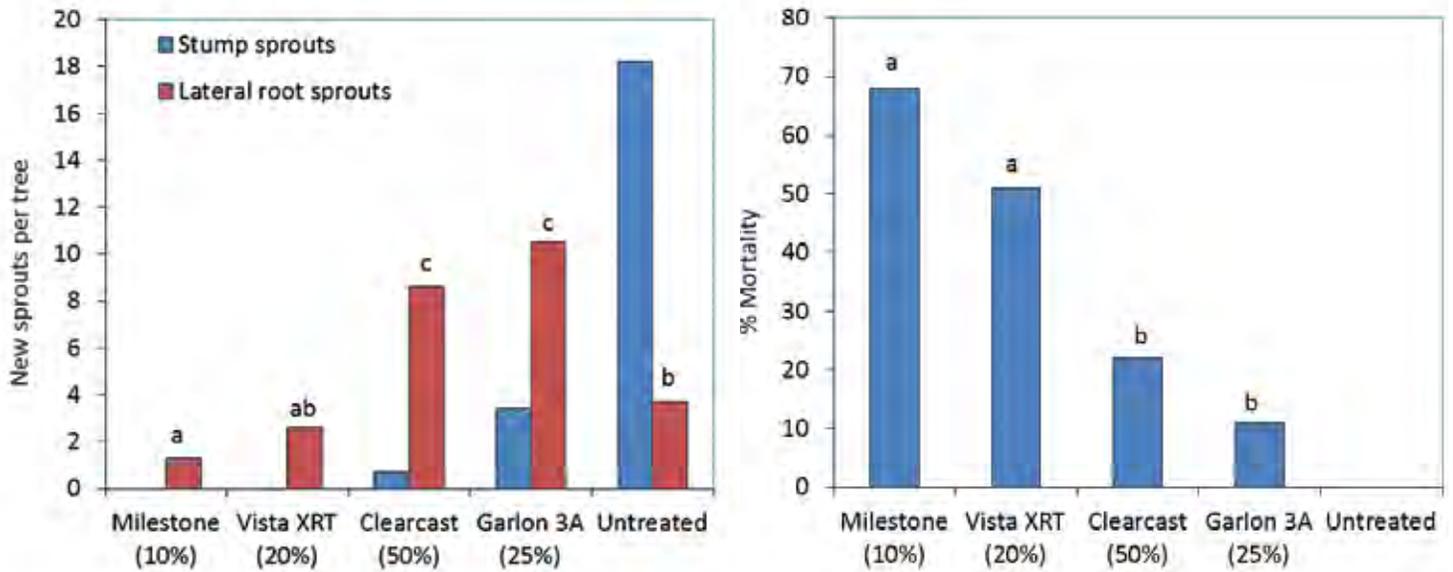


Figure 4. Chinese tallowtree sprouting response (left) and mortality (right) 21 months after cut stump treatment. Treatment means followed by the same letter are not different ($p=0.05$). Images courtesy Stephen Enloe.

gave a clearer indication of treatment effects. Aminocyclopyrachlor and Clearcast reduced Chinese tallowtree foliar cover to 16 and 12%, respectively, at the end of the second growing season after treatment (Figure 6, left). These were significantly lower than Vista XRT and Milestone, which reduced foliar cover by 53 and 58%.

Trees treated with Garlon 3A had almost completely recovered and had 86% foliar cover, which was not different from the untreated controls. Chinese tallowtree mortality was greatest with aminocyclopyrachlor and Clearcast. Milestone and Vista XRT were numerically lower, but a high degree of variation resulted in

a statistical “muddling” of the treatments (Figure 6, right), and Garlon 3A resulted in only 11% mortality. This type of foliar treatment approach (cutting large trees and subsequently treating new growth a few months later) is a worst-case scenario for foliar treatment. In this situation, there is very little leaf area compared to the total

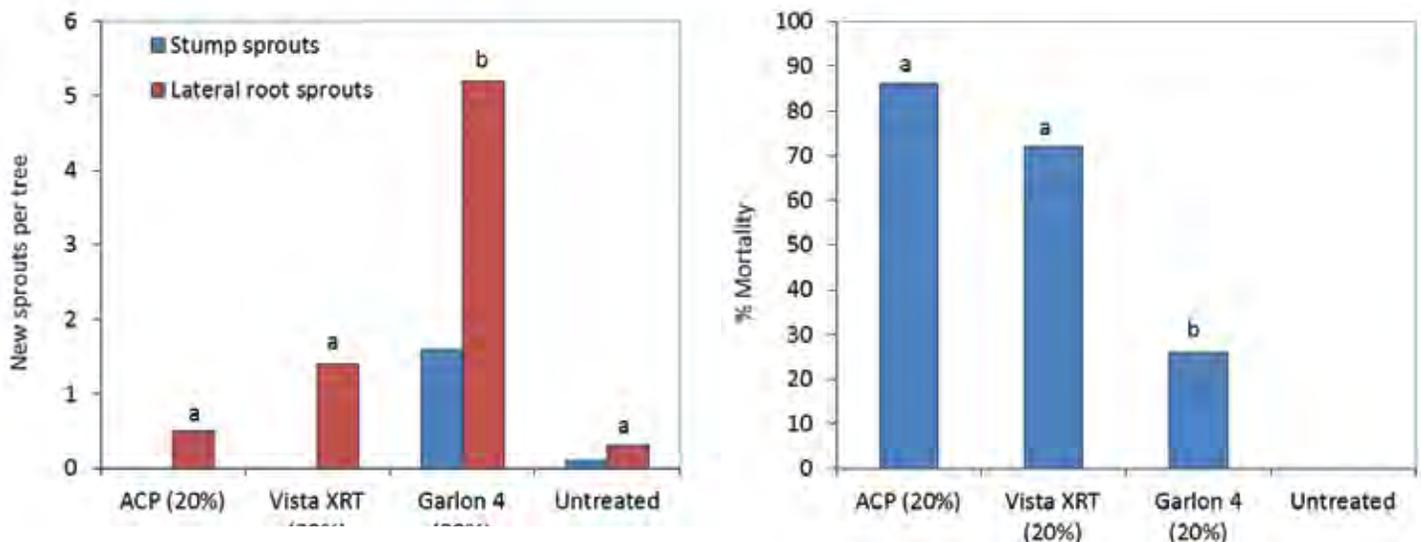


Figure 5. Chinese tallowtree sprouting response (left) and mortality (right) 21 months after basal bark treatment. Treatment means followed by the same letter are not different ($p=0.05$). ACP = Aminocyclopyrachlor. Images courtesy Stephen Enloe.

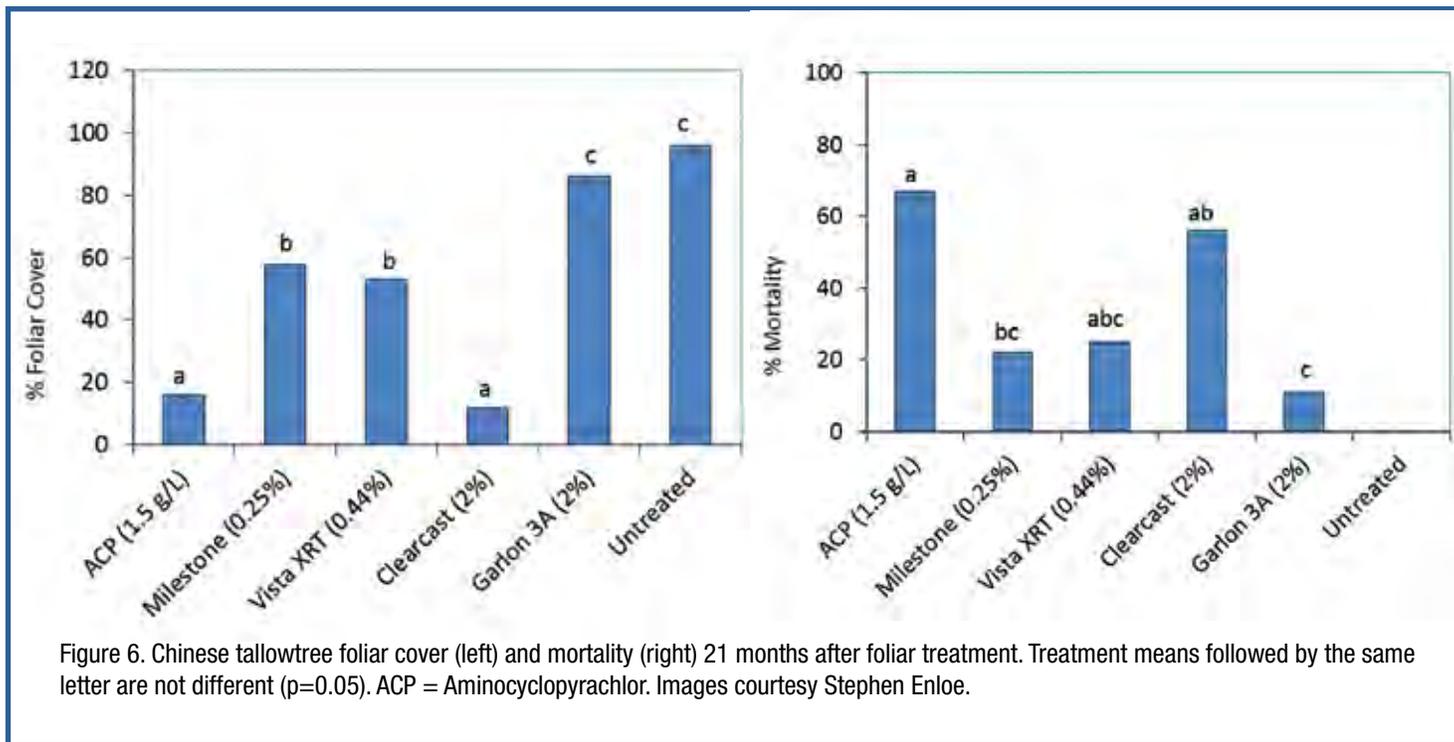


Figure 6. Chinese tallowtree foliar cover (left) and mortality (right) 21 months after foliar treatment. Treatment means followed by the same letter are not different ($p=0.05$). ACP = Aminocyclopyrachlor. Images courtesy Stephen Enloe.

root mass and achieving excellent control is often very difficult. Had we treated seedlings or saplings, our foliar treatment results would have likely been much better.

These studies demonstrated that there are several promising new herbicides with considerable activity on Chinese tallowtree, including aminocyclopyrachlor, Milestone, Vista XRT, and Clearcast. In every study, one or more of these provided significantly better control than the triclopyr commercial standards. Aminocyclopyrachlor is available in certain products including Method, Streamline, and others. These are currently labeled for use in many non-crop areas including natural areas, riparian areas, and many wetland sites that experience some dry periods. Milestone is labeled in similar areas and is also expected to be registered for certain aquatic uses in the near future. Vista XRT is currently labeled for use in non-cropland sites including rights of ways and non-irrigation ditch banks. Clearcast is registered for use in and around many aquatic sites and natural areas. Future research will help refine rates and optimal application timings of these newer herbicides, which will greatly increase the number of tools in the toolbox for Chinese tallowtree control.

Stephen Enloe (sfenloe@ufl.edu) is an Invasive Plant Extension Specialist at the University of Florida IFAS Center for Aquatic and Invasive Plants in Gainesville. Nancy

Loewenstein (loewenj@auburn.edu) is a Research Fellow IV and Extension Specialist in the School of Forestry and Wildlife Sciences at Auburn University.



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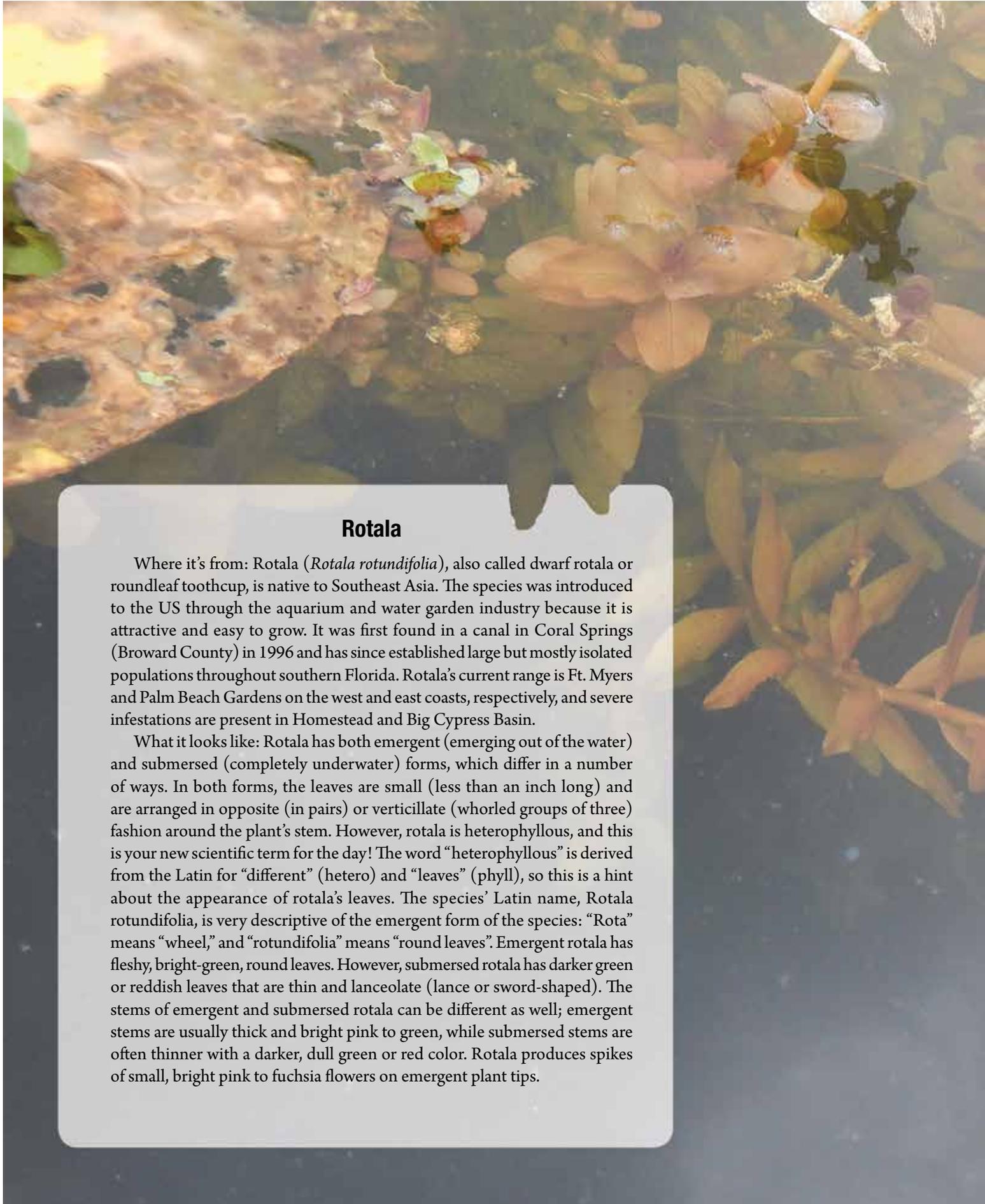
A close-up photograph of a rotala plant stem. The stem is reddish-brown and upright. It has several pairs of opposite, rounded, green leaves. At the top of the stem, there is a cluster of small, light green flowers or buds. The background is blurred, showing more of the plant and some water.

Lookalike aquatic plants

Figure 1. Emergent stem and leaves of rotala. Photo courtesy Lyn Gettys.

by Lyn A Gettys

How often have you played the “ID at 65” game? You’re driving down the Turnpike and you see a canal infested with... something. It’s almost impossible to identify a submersed plant when you’re moving at a high rate of speed, but it can be challenging even when you’re sitting in a stopped boat or standing still on a canal bank with a piece of the plant in your hand. That’s because a number of the submersed plants in Florida’s waters are very similar in appearance. This is particularly true of rotala, lemon bacopa and redstem ludwigia. All are mostly submersed plants with creeping shoreline growth habits and roundish leaves. Being able to identify these three species can be important because knowing a plant’s identity opens the door to all sorts of useful information, including its growth potential and how to control it if management is needed. Hopefully, this article will be a handy guide to help you sort out these lookalike species.



Rotala

Where it's from: Rotala (*Rotala rotundifolia*), also called dwarf rotala or roundleaf toothcup, is native to Southeast Asia. The species was introduced to the US through the aquarium and water garden industry because it is attractive and easy to grow. It was first found in a canal in Coral Springs (Broward County) in 1996 and has since established large but mostly isolated populations throughout southern Florida. Rotala's current range is Ft. Myers and Palm Beach Gardens on the west and east coasts, respectively, and severe infestations are present in Homestead and Big Cypress Basin.

What it looks like: Rotala has both emergent (emerging out of the water) and submersed (completely underwater) forms, which differ in a number of ways. In both forms, the leaves are small (less than an inch long) and are arranged in opposite (in pairs) or verticillate (whorled groups of three) fashion around the plant's stem. However, rotala is heterophyllous, and this is your new scientific term for the day! The word "heterophyllous" is derived from the Latin for "different" (hetero) and "leaves" (phyll), so this is a hint about the appearance of rotala's leaves. The species' Latin name, *Rotala rotundifolia*, is very descriptive of the emergent form of the species: "Rota" means "wheel," and "rotundifolia" means "round leaves". Emergent rotala has fleshy, bright-green, round leaves. However, submersed rotala has darker green or reddish leaves that are thin and lanceolate (lance or sword-shaped). The stems of emergent and submersed rotala can be different as well; emergent stems are usually thick and bright pink to green, while submersed stems are often thinner with a darker, dull green or red color. Rotala produces spikes of small, bright pink to fuchsia flowers on emergent plant tips.



Figure 2. Submersed stems and leaves of rotala. Photo courtesy Lyn Gettys.

Lemon bacopa

Where it's from: Lemon bacopa (*Bacopa caroliniana*), also called blue waterhyssop, is native to the US and is broadly distributed throughout Florida. Although lemon bacopa is usually considered a desirable and beneficial plant, it can become weedy in some situations. This is especially true in flood control canals, where any submersed vegetation can restrict water flow and increase the risk of flooding after heavy rainfall.

What it looks like: Like rotala, lemon bacopa grows under both emergent and submersed conditions, but there are only minor differences in the appearance of the two forms. In both forms, the leaves are roundish (sometimes with small notches in the margins), thick and fleshy, less than an inch long and arranged in pairs. Emergent leaves are usually bright green and aromatic when crushed, with a scent that has been described as having licorice, anise or lemon elements. Submersed leaves are darker in color and tend to be unscented. Slight differences exist between the stems of emergent and submersed lemon bacopa too. Both forms are thick and stocky, but emergent stems are usually red or green and covered with fine hairs, while submersed stems are darker and hairless. Lemon bacopa produces single blue flowers on emergent tips.



◀ Figure 3. Emergent stem and leaves of lemon bacopa. Photo courtesy Lyn Gettys.

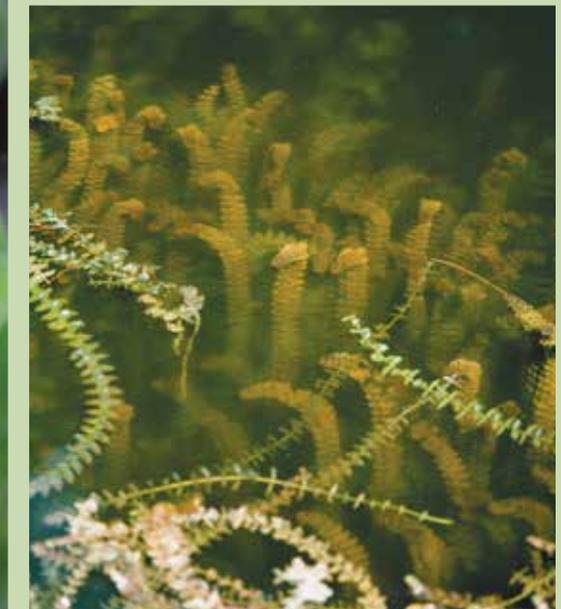
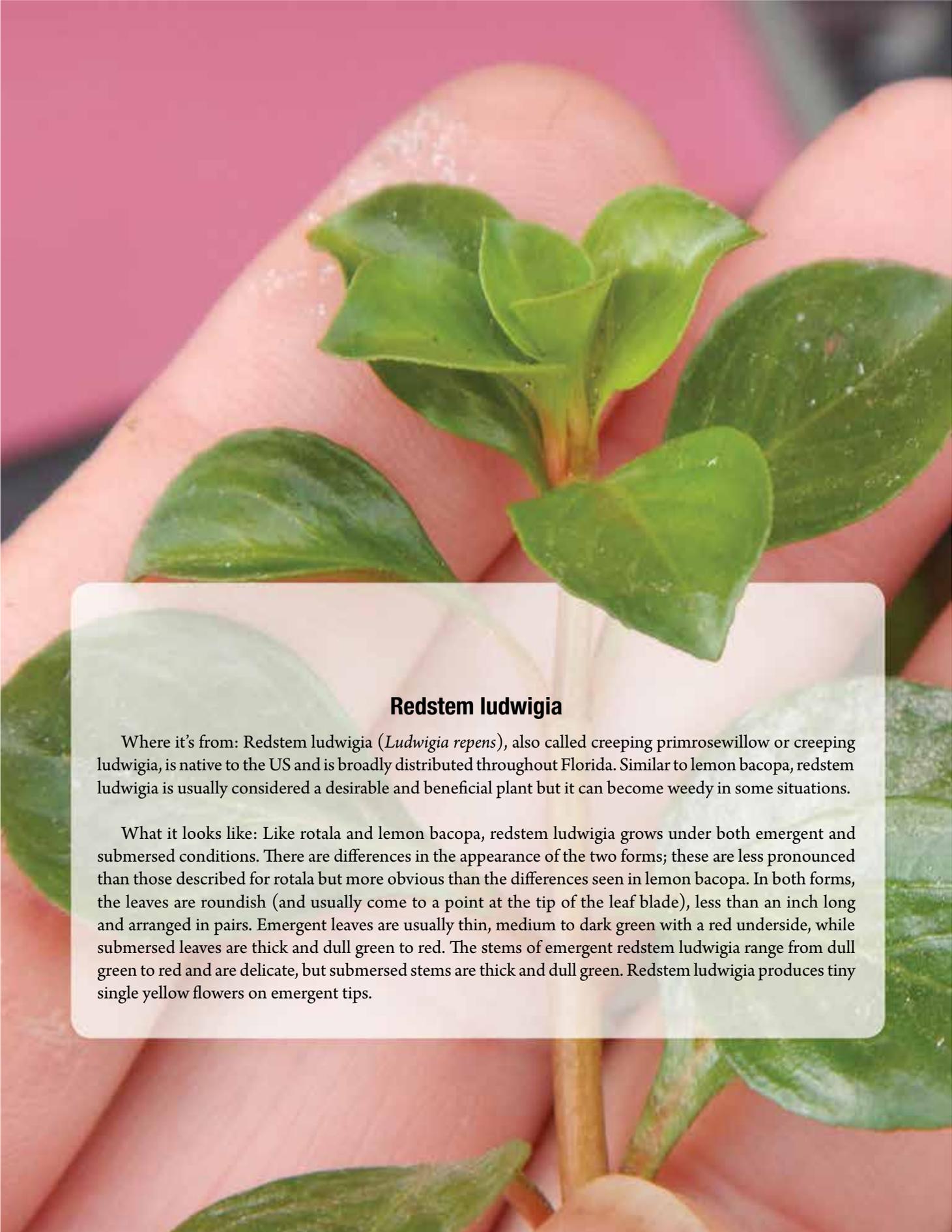


Figure 4. Submersed stems and leaves of lemon bacopa. Photo courtesy Dave Sutton.



Redstem ludwigia

Where it's from: Redstem ludwigia (*Ludwigia repens*), also called creeping primrosewillow or creeping ludwigia, is native to the US and is broadly distributed throughout Florida. Similar to lemon bacopa, redstem ludwigia is usually considered a desirable and beneficial plant but it can become weedy in some situations.

What it looks like: Like rotala and lemon bacopa, redstem ludwigia grows under both emergent and submersed conditions. There are differences in the appearance of the two forms; these are less pronounced than those described for rotala but more obvious than the differences seen in lemon bacopa. In both forms, the leaves are roundish (and usually come to a point at the tip of the leaf blade), less than an inch long and arranged in pairs. Emergent leaves are usually thin, medium to dark green with a red underside, while submersed leaves are thick and dull green to red. The stems of emergent redstem ludwigia range from dull green to red and are delicate, but submersed stems are thick and dull green. Redstem ludwigia produces tiny single yellow flowers on emergent tips.



Figure 6. Submersed stems and leaves of redstem ludwigia (growing with alligatorweed).
Photo courtesy Lyn Gettys.

Let's recap...

All three species described above grow under emergent and submersed conditions, so they can be found growing above the waterline along canal banks, pond margins, ditches and similar areas, as well as in water that is up to 6 feet deep. All have round or roundish leaves that are usually attached in pairs at each node. They look a lot alike, so what's a resource manager to do? Here are some tips that may be useful for separating these plants from one another.

Growth situation: plant growing under emergent conditions

Emergent Leaves

- Step 1: Leaves are bright green and round or roundish – go to step 2
Leaves are medium to dark green with a pointed tip and may have a red underside: redstem ludwigia
- Step 2: Leaves are unscented: rotala
Leaves are aromatic when crushed and smell like licorice: lemon bacopa

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Figure 7. Flowers of rotala (left) and lemon bacopa (right). Redstem ludwigia flowers are small and yellow (not shown). Photos courtesy Lyn Gettys.

Emergent Stems

Step 1: Stems are thick and green, red or bright pink – go to step 2

Stems are thin and dull green or red – redstem ludwigia

Step 2: Stems are green or red and covered with fine hairs: lemon bacopa

Stems are green to pink and hairless: rotala

Flowers

Step 1: Flowers are bright pink and form a spike: rotala

Flowers are single and blue: lemon bacopa

Flowers are small and yellow: redstem ludwigia

Growth situation: plant growing under submersed conditions

Leaves

Step 1: Leaves are thick and round or roundish – go to step 2

Leaves are thin and lanceolate: rotala

Step 2: Leaves have pointed tips and may be red: redstem ludwigia

Leaves have rounded tips and may have notches on the margins: lemon bacopa

Stems

Step 1: Stems are thick and green – go to step 2

Stems are thin and dull green or red – rotala

Step 2: Stems are dull green (emergent stems have fine hairs): lemon bacopa

Stems are dark green (emergent stems are hairless): redstem ludwigia

Flowers: n/a; flowers are only produced on emergent parts of the plant

So now what?

You've determined the identity of your mystery plant; how can that help you? It's likely that your next step will be to explore control options, because if you've gone to the trouble to identify a plant, it's probably causing problems in your system. Management of emergent plants growing along banks is usually fairly straightforward – plants can be mown, dug up or treated with glyphosate or imazapyr. Submersed populations can be trickier to manage, so here are some of the tools at your disposal.

Mechanical harvesting: All three species can be mechanically harvested, but

plant material removed from the water should be handled differently than hydrilla and other completely submersed species. Offloading harvested hydrilla onto a canal bank works well, but it can actually spread populations of rotala, lemon bacopa and redstem ludwigia along the shoreline because all three species grow fine under “high and dry” conditions. Harvested material that is piled on the bank may root and create an emergent population, so plant material may need to be transported off-site to prevent new infestations. Also, all three species can be propagated by vegetative means, so the fragments produced during mechanical harvesting may produce roots and result in spread of the species.

Biocontrol: There are no host-specific biological control agents for rotala, lemon bacopa or redstem ludwigia. Triploid grass carp, which are generalist herbivores that eat a wide variety of aquatic plants, don’t like these plants – they prefer hydrilla. Therefore, they are unlikely to consume enough plant material to provide even minimal control of any of these species.

Chemical control: This is where knowing the identity of your mystery plant can be most useful because there is no silver bullet that will control rotala, lemon bacopa and redstem ludwigia.

Rotala: The products most commonly used for rotala control are the auxins 2,4-D and triclopyr at 2 and 4 ppm, respectively. Both provide excellent control of rotala, but care should be taken when using auxins because many economically important crops are extremely sensitive to even small amounts of these plant hormones. Greenhouse studies have shown that foliar applications of bispyribac or imazamox (at 1 or 64 ounces per acre, respectively) and submersed application of fluridone at 37 ppb may be good strategies for rotala control. In systems where water pH is below 8, a tank mix of flumioxazin at 200 ppb and diquat at 0.37 ppm can be effective as well. Field trials are planned to verify these findings.

Lemon bacopa: Herbicide choices for lemon bacopa are limited. Imazapyr is effective but only on emergent plants; penoxsulam may provide partial control



Figure 8. Rotala piled along a canal bank after mechanical harvesting. Photo courtesy Ellen Allen/SFWMD.

of submersed growth. Other active ingredients are not known to cause significant damage to lemon bacopa. Some of the “new to aquatics” chemistries that have been introduced in the last few years may have activity on this species, but most research

is focused on management of introduced invasive weeds as opposed to native plants such as lemon bacopa that can become weedy under the right conditions.

Redstem ludwigia: Little information is available regarding herbicide activity on redstem ludwigia. As with lemon bacopa, some of the new aquatic chemistries may have activity on this species. Look on the bright side; of the three species outlined in this article, redstem ludwigia is the least likely to “break bad” and grow out of control, so the odds that you’ll have to intensively manage redstem ludwigia are slim.

Dr. Lyn Gettys (lgettys@ufl.edu) is an Assistant Professor of Agronomy at the University of Florida IFAS Fort Lauderdale Research and Education Center.

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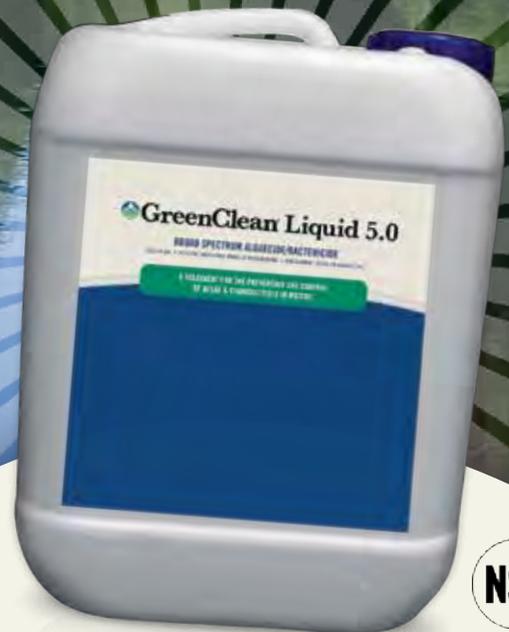
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RECAP: The 2015 UF/IFAS Aquatic Weed Control Short Course

The 2015 Short Course, co-hosted by Lyn Gettys and Bill Haller at the Coral Springs Marriott, drew over 490 attendees from around the country (and we had several international visitors as well!). This year's turnout was the highest we've had in a number of years, and we appreciate everyone coming together at this annual training event for weed managers throughout Florida and beyond. Our sponsors outdid themselves this year by providing the support needed to keep Short Course costs affordable for attendees; as always, our sponsors were great sources of information too. Conference coordinator Jasmine Garcia kept things running smoothly; she and her staff made sure everything went as planned and, most importantly, ensured we had plenty of coffee and tasty treats during the breaks. Tamara James, Environmental Manager for FDACS' Division of Agricultural Environmental Services, was on hand to answer questions about licensing, CEUs and anything else an applicator might need to know.

Welcome to the 2015 UF/IFAS Aquatic Weed Control Short Course!



Jasmine and Mandy (left) set up Jeff Miller with his registration materials
Bill Haller (below) discusses aquatic weed control in Florida



Tamara James (above) provides guidance to an applicator

Greg MacDonald outlines how to design a weed management program



Brian Parker (above) gets organized for a day of learning





Break time is networking time!

Short Course speakers are nationally recognized for their expertise in the field of aquatic resource management. In addition to speakers from UF and industry, we were fortunate to be able to host Ken Wagner, who is considered an international authority on algae biology and control, and Fred Whitford, who has a knack for bringing seemingly minor details that are often overlooked into the spotlight to emphasize how important it is to “sweat the small stuff”. Our friend Orifice P. Nozzlehead, the alter ego of AERF executive director Carlton Layne, also made an appearance and highlighted applicator responsibility and professionalism.

Plant identification sessions gave attendees the chance to learn about



And time (left) to chow down!

And time (left below) to catch up with friends and colleagues!



Mike Bodle (above) teaches upland and natural area plant identification

Brent Sellers (left) explains calibration and math shortcuts, tips and tricks

Live specimens (far left) of upland and natural area plants available for attendees to examine



upland and aquatic plants and to see live specimens of the native and invasive flora they might encounter in the field. Special math review and calibration sessions prepared applicators to take the exams on Thursday, and the IFAS Bookstore was on hand to sell study guides, plant identification books, and other useful materials. A total of 191 core or category exams were completed by the 100 individuals who took exams on Thursday – this is close to a record too.

Based on feedback from attendees, the 2015 Short Course was the best yet, and that's due to the hard work of our speakers, organizers, sponsors, and you! Thanks for your participation – we'll see you in Coral Springs again next year!

PS – Did you miss part of a talk at the 2015 Short Course? Misplace your book of presentations? You can access a pdf of the book at www.conference.ifas.ufl.edu/aw/AW_2015_Book_of_Presentations.pdf

Lyn Gettys (right) teaches aquatic plant identification

Live specimens (below) of aquatic plants available for attendees to examine



Ken Wagner (below left) discusses algae biology, identification and control

Fred Whitford (below) outlines the importance of knowing what's in your tank



Orifice P. Nozzlehead (aka Carlton Layne, left) highlights applicator professionalism

More networking during a break (right)



Figure 18: Attendees soak up information



The CAIP booth with loads of information for resource managers



The IFAS bookstore (above) sells exam study prep guides, plant identification books and other useful material

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AERF - What Is It Wednesday?!?

Are you a social media junkie? Need to add to your wardrobe? Good with aquatic plant ID? Well, we have the game for you! Next time you are perusing your timeline on a Wednesday, stop by the Aquatic Ecosystem Restoration Foundation's Facebook page and test your identification skills. Each and every Wednesday, AERF posts a photo of something aquatic-related. The first person to guess correctly will receive a FREE AERF t-shirt. Answers will be announced each Thursday, so the next time you are bored on a Wednesday, stop by and play!



2015 APMS Annual Meeting – Myrtle Beach, SC

The 2015 meeting of the Aquatic Plant Management Society will be held July 12 through 15 at the Hilton Myrtle Beach Oceanfront Resort in Myrtle Beach, South Carolina. The meeting will be held in conjunction with the annual meeting of the South Carolina Aquatic Plant Management Society. The meeting promises to showcase a great deal of new research and will be highlighted by events such as the annual duck race, golf tournament, fishing tournament, and MORE! Visit www.apms.org for more information on registration

and setting up accommodations. We look forward to seeing you all in July!

14th International Symposium on Aquatic Plants – Edinburgh, Scotland

Looking to travel abroad in 2015? Why not head to the 14th International Symposium on Aquatic Plants, September 14 through 18 in Edinburgh, Scotland? The meeting will be held in the beautiful Playfair Library of Edinburgh, the historic capital of Scotland. Interest in aquatic plants and their management has spread worldwide and the ISAP program will reflect just that. This program is intended to appeal to both scientists and managers



alike. For more information, visit <https://sites.google.com/site/aquaticplants2015>

34th Annual MSAPMS Conference – Mobile, AL

The MidSouth Aquatic Plant Management Society will hold their 34th annual meeting at the Renaissance Mobile Riverview Plaza Hotel in Mobile, Alabama on September 14 through 16. The 2015 meeting will kick off with a welcoming social on Monday evening, followed by an aquatic plant identification workshop Tuesday morning, technical talks on Wednesday morning and capped off with an awards banquet on Wednesday night. Students that contribute an oral presentation will receive free lodging (shared with another student), free conference registration, and a check for \$100. Students should contact the current President-Elect and Program Chair to enroll in this opportunity. Reservations for hotel accommodations at the Renaissance Mobile Riverview Plaza Hotel must be made before August 21, 2015 by calling

1-800-922-3298 or 251-438-4000. When making your reservations please request the MidSouth Aquatic Plant Management Society Reference code #M-24A01B4. Hotel and reservation information can be found online at the Marriott website.



39th Annual FAPMS Conference – Lake Buena Vista, FL

It is NEVER too early to start thinking about attending the 2015 Florida Aquatic Plant Management Society Conference, which will be held October 5 through 8 at the Buena Vista Palace Hotel and Spa in Lake Buena Vista, Florida. As always, this year's conference will shape up to bring you the best in research and management of aquatic plants in Florida and beyond.

Stay tuned for more about the FAPMS meeting in Aquatics Magazine or visit www.fapms.org for updates.



“Spreading” Invasive Plant Knowledge in our Schools

The Tennessee Valley Authority, in partnership with the MidSouth APMS and the Lake Guntersville Stakeholders Board, would like to facilitate vital discussion among educators in the State of Alabama regarding invasive and aquatic plant management in the Tennessee Valley. The group will hold a 2-3 day meeting and is inviting teachers and environmental educators from around the state to attend. TVA and MSAPMS will provide expert instruction in aquatic and invasive plant identification and will discuss manage-

ment, as well as impacts to the environment and economy. The intention of this workshop is to provide educators with material to be shared in their classrooms regarding such issues, while also remaining congruent with Alabama State Curriculum. A meeting location and time will be forthcoming. If you would like to participate, or have questions, contact Brett Hartis at bmhartis@tva.gov.



Northeast APMS Student Scholarship

The Northeast Aquatic Plant Management Society provides scholarship funds designed to encourage and involve exceptional graduate students in the field of aquatic plant management. Awards may be used as a stipend, for research budget expenses (travel, supplies, etc.), to defer fees, to defray living expenses for summer research, or any combination of these items. Applicants should be enrolled in a Master's or Doctoral level research program with a college or university in the northeast region of the United States, with a research focus in the area of aquatic plant management. There are no deadlines for application. Applications that are received by the Scholarship Committee will be held until the next scheduled Board of Directors meeting for review. NEAPMS will review applications twice annually, once in September and once in January, and make awards based on candidate qualifications and funding availability. For more information, visit <http://www.neapms.org/graduate-student-scholarship-award/>

If you would like to have your event, workshop, or announcement considered for Aquavine, please contact Brett Hartis at bmhartis@tva.gov.

Dr. Brett Hartis (bmhartis@tva.gov) is Program Manager of the Tennessee Valley Authority's Aquatic Plant Management Program and is located in Guntersville, AL.

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Calendar of Events 2015

June 25

**South Florida Aquatic Plant
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www.sfapms.org

July 12 – 15

**Aquatic Plant Management Society
55th Annual Meeting**
Myrtle Beach SC
apms.org

July 22

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August 4 – 7

**American Society for Horticultural
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ashs.org

August 16 – 20

**American Fisheries Society 145th
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Portland OR
2015.fisheries.org/

September 14 – 16

**MidSouth Aquatic Plant Management
Society**
Mobile AL
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October 5 – 8

**Florida Aquatic Plant Management
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Paul C. Myers Applicator Dependent Scholarship

The Florida Aquatic Plant Management Society Scholarship and Research Foundation, Inc. is pleased to announce the availability of the *Paul C. Myers Applicator Dependent Scholarship*, which provides up to \$1,500 to deserving dependents of FAPMS members. The scholarship is based on:

1. The applicant's parent or guardian having been a FAPMS member in good standing for at least three consecutive years
2. Financial need, which will be determined based on need and the expected family contribution amount indicated on the processing results of a Student Aid Report (OMB No. 1845-0008). This report is available by completing a Free Application for Federal Student Aid Federal Form available online at fafsa.ed.gov
3. The applicant being a high school senior entering college the next academic year, attending community college, or being a college undergraduate
4. An evaluation of the quality of the application and required essay by the Scholarship Selection Committee, which is composed of three FAPMS members and four FAPMS Scholarship and Research Foundation members
5. Submission of a completed application by June

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