Aquatics

FALL/WINTER 2017

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Aquatics

FALL/WINTER 2017 Volume 39, Number 3/4

COVER

"Boss Man in a Bucket." Rodney Tillman with Fellsmere Water Control District measuring a clogged culvert. According to photographer, Joyce Hertel, "He is the best boss man ever." Joyce took third place in the Aquatic Operations division of the FAPMS photo contest. See other winning photos on page 14-15.

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The mission of FAPMS is "To Preserve Florida's Aquatic Heritage." FAPMS was formed in 1976 and provides a forum for those interested in aquatic plant management to meet, discuss and exchange ideas and information.

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A Selective Graminicide —
a much needed component for invasive aquatic grass management

By Stephen F. Enloe and Michael D. Netherland

In Florida, invasive aquatic grasses constitute one of the greatest challenges for managers. Species such as torpedograss (*Panicum repens* L.) and paragrass (*Urochloa mutica*) have plagued managers for many decades while West Indian marsh grass (*Hymenachne amplexicaulis*) has rapidly expanded over the last decade. More recent species such as Tropical American watergrass (*Luziola subintegra*) are threatening to do the same. These species have arrived in the US via many pathways: as crop seed contaminants, for forage testing, in soil stabilization projects and even uncertain means.

In general, invasive aquatic grasses often exhibit similar aggressive growth habits including the ability to form dense monotypic stands that crowd out other plants. Invasive aquatic grasses do not simply move in to the niche native grasses fill. They often exhibit broad tolerance to the variable conditions across emergent and riparian habitats. They lack the natural enemies from their native range that might otherwise keep their growth in check. Although sexual reproduction varies among species, all spread through aggressive vegetative growth. Below-water biomass often far exceeds the emergent growth.

Plant community changes resulting from invasive aquatic grasses cause significant structural and functional changes to aquatic ecosystems, generally to the detriment of many key species. Across Florida, many highly diverse aquatic systems have been greatly homogenized by invasive grasses. This trend is not limited to Florida but has also occurred throughout the US with other wetland invaders such as giant reed (*Arundo donax*), reed canarygrass (*Phalaris arundinaceae*), and most certainly common reed (*Phragmites australis*).

Management options for invasive grasses in both upland and aquatic systems have often been frustratingly limited. Prescribed fire, one of nature's most effective vegetation management tools, is rarely successful when used as a stand-alone approach. Biological control is almost non-existent for invasive grasses due to the frequent close relationship to other Poaceae family members we call food (rice, oats, corn, wheat). Grasses often evolved under intense grazing pressure and now possess an incredible tolerance for repeated defoliation. This limits the effectiveness of large herbivores and mechanical controls, even where they are feasible. Cultural controls such as manipulating water levels are rarely if ever under the control of the aquatic plant manager and restoring historic

Figure 1. Percent biomass reduction of six native aquatic plants at 8 weeks following foliar application of glyphosate (GLY), imazapyr (IMA), clethodim (CLE), fluazifop-p-butyl (FLU), and sethoxydim (SET). Summer and fall treatments were applied on June 3 and October 3, respectively. Each bar represents the average of three replicates. Asterisks above bars denote a significant difference between the biomass of a given herbicide and the untreated control. Negative values represent a positive growth response even though they are not different from the untreated reference.

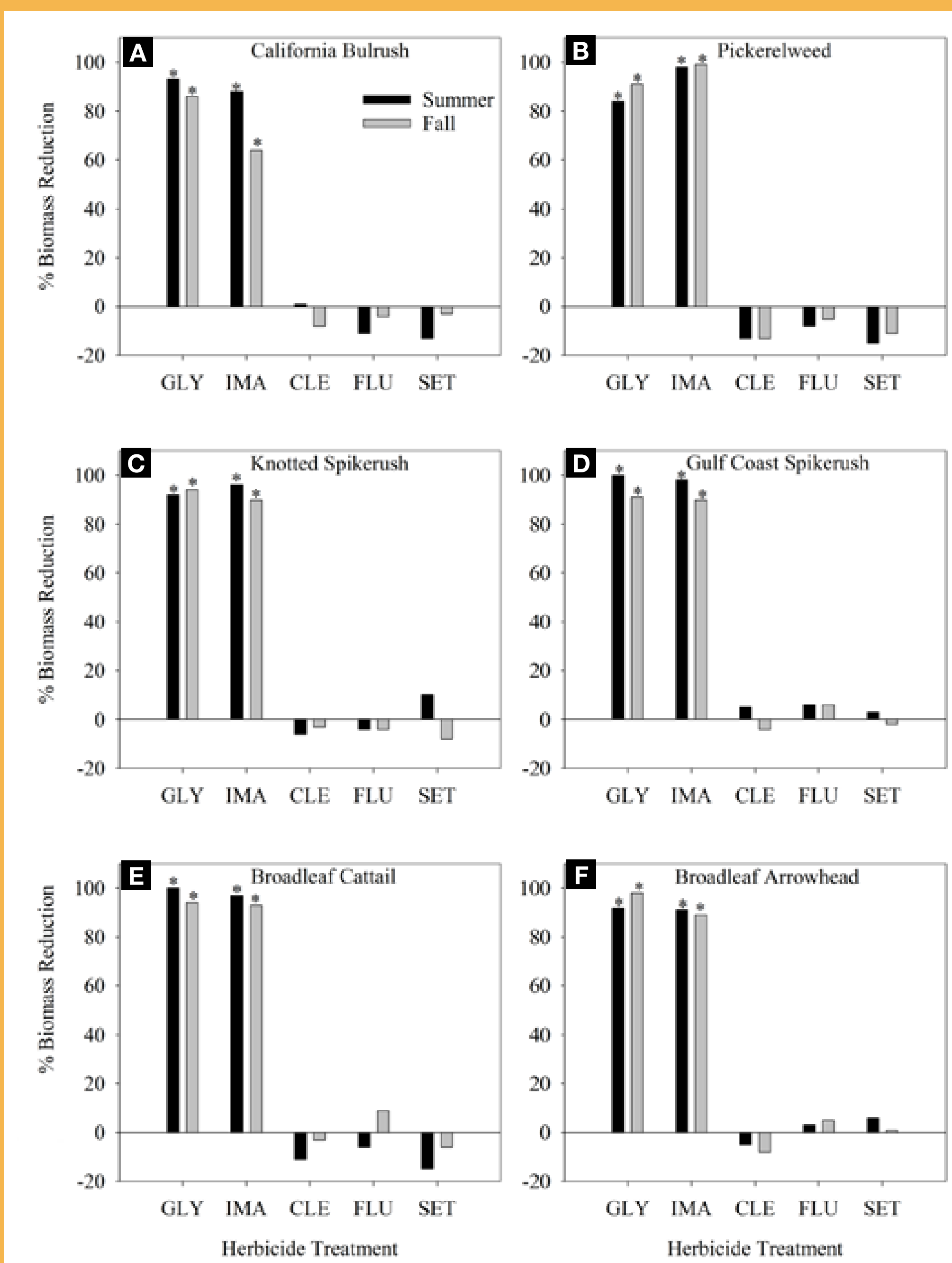
water level fluctuations has not solved the problem either.

In the end, aquatic and riparian area managers generally turn to two herbicides: glyphosate and imazapyr. Both are what I call big, non-selective hammers and I additionally like to refer to imazapyr as the "800 pound gorilla" of the two options. Across the vast body of research literature and operational experience, imazapyr is pound for pound the most effective invasive grass herbicide available. Glyphosate is a sometimes close, sometimes distant second to imazapyr. The chemical characteristics and mode of action of imazapyr drive its effectiveness. It is readily absorbed in foliar applications and translocates well into roots, rhizomes, and stolons of grasses. It works very slowly, inhibiting the production of amino acids that are necessary for protein synthesis. In fact, it works so slowly that it may require several months for foliar burndown of target grasses and may continue to work for over 12 months in the rhizomes of many grass species. In addition, imazapyr can persist for several months in soil where it can be absorbed by plant roots.

Glyphosate is also readily absorbed into leaves and translocates well throughout plants. It inhibits the production of a separate group of amino acids necessary for protein synthesis. However, it generally does not provide the high level of root and rhizome kill typically found with imazapyr. Glyphosate also has no soil activity, so it has no back up plan if foliar absorption is poor.

Given that neither herbicide is a silver bullet, retreatment is generally required. Within this context, the broad scale effectiveness of both herbicides is also their Achilles heel in ecosystem management, especially from a restoration context. Selectivity is generally lacking for glyphosate and any non-target plants that are sprayed will often also be controlled. This issue is even greater for imazapyr due to its persistent soil activity. This lack of selectivity is not necessarily an issue when treating interior portions of large dense stands of invasive grasses, since there are few desirable plants remaining. However, when managers draw the line to contain invasive grasses, or are spot treating areas of recent invasion, they are often doing so at the interface of diverse native plant communities where selectivity becomes a serious issue. In those situations, two things can happen. First, the desirable plants take a hit from the treatment. Second, they are slower to recover than invasive grasses. A cyclic pattern of treatment and retreatment can result in an unacceptable loss of desirable plants. Does this mean we should cease using glyphosate and imazapyr for aquatic invasive grass control? Absolutely not! They are still indispensable to management. However we must overcome this management plateau to improve selectivity and protect desirable plants.

In agriculture and non-crop settings, a group of herbicides active only on grasses (graminicides) has been has been utilized for over thirty years. Although there are at least eight different graminicides, three are particularly well known: sethoxydim, fluazifop-p-butyl, and clethodim. Dicots are naturally insensitive to graminicides. This has resulted in improved grass weed control in many broadleaf crops. However, graminicides have always been somewhat weak on many large, perennial grasses resulting in limited use beyond agriculture.



These graminicides have not been extensively investigated for aquatic grasses. Furthermore, many non-grass aquatic plants, especially monocots, have never been examined for graminicide selectivity. Given the strong interest in improving selectivity in aquatic grass control our objective was to evaluate the impact of these three key graminicides on six native non-grass monocot aquatic plants, one native grass, and the exotic torpedograss in controlled mesocosm studies. If the selectivity holds and efficacy is good enough, this would indeed warrant additional testing.

To address this question of selectivity, mesocosm trials were conducted at the University of Florida, Center for Aquatic and Invasive Plants in Gainesville, FL. We chose six native species for testing. These included three members of the Cyperaceae family: California bulrush (*Schoenoplectus californicus*), knotted spikerush (*Eleocharis interstincta*), and Gulf Coast spikerush (*Eleocharis cellulosa*). We also selected three additional monocots, one each from Typhaceae [broadleaf cattail (*Typha latifolia*)], Pontederiaceae [pickerelweed (*Pontederia cordata*)], and Alismataceae [broadleaf arrowhead (*Sagittaria latifolia*)]. We also selected one native and one non-native Poaceae, Egyptian paspalidium (*Paspalidium geminatum*) and torpedograss (*Panicum repens*), respectively.

Multiple pots of each species were propagated and randomly placed in eighteen mesocosm tanks in the late spring of 2014. Water level was held at 38 cm throughout the study and all plants were grown for six weeks. Two experimental runs resulted in treatment in either June or October. The surface area of the tanks was calculated and each herbicide was applied via a CO_2-pressurized sprayer equipped with a hand-held, single nozzle sprayer. The herbicide treatments included Select (clethodim), Fusilade II (fluazifop-p-butyl), Poast (sethoxydim), Rodeo (glyphosate), and Habitat (imazapyr). A non-ionic spray adjuvant was added to the fluazifop-p-butyl, glyphosate, and imazapyr treatments. A methylated seed oil was added to the clethodim and sethoxydim treatments. Following treatment, plants were maintained for eight weeks before harvest. Aboveground plant biomass was then harvested for all species and oven dried to a constant weight at 65 C. Additionally, belowground biomass was harvested for torpedograss.

Each herbicide treatment and the untreated control were replicated in three tanks and treatments were arranged in a completely randomized design. Post-treatment data are presented as the percent biomass reduction of the treated plants compared to the untreated controls for each species in each experimental run.

The results were extraordinarily clear in these studies across both treatment timings. Glyphosate and imazapyr resulted in a high level of injury to every species tested. Glyphosate reduced final biomass by 81 to 100% across all non-grass native species (Figure 1A-F). When treated and untreated final biomass for each species was compared, the negative impact of glyphosate was highly significant for all species. Imazapyr resulted in a similar pattern and reduced final biomass of all native species by 64 to 99%. Excluding California bulrush, imazapyr actually reduced biomass of all native species by 89% or greater across both treatment timings.

For the six native non-grass species, the three graminicides presented a very different outcome that was in complete contrast to glyphosate and imazapyr. Final biomass of all six non-grass species was not different from untreated plants following treatment with clethodim, fluazifop-p-butyl, or sethoxydim (Figure 1A-F). The simple translation is this: all three grass-selective products performed similarly with a complete lack of impact to native (non-grass) emergent aquatic vegetation.

Some additional observations during the study indicated glyphosate injury manifested more rapidly than imazapyr. For imazapyr, injury would have likely been more severe if the experiment was continued due to its slow-acting nature. In contrast, there were no sustained injury symptoms noted on non-grass native species for clethodim, fluazifop-p-butyl, or sethoxydim following either summer or fall applications. Immediately following treatment, some potential formulation solvent or surfactant burn associated with the fluazifop-p-butyl application was noted. However, plants recovered from these symptoms within a few days after the application and there was no impact on final biomass.

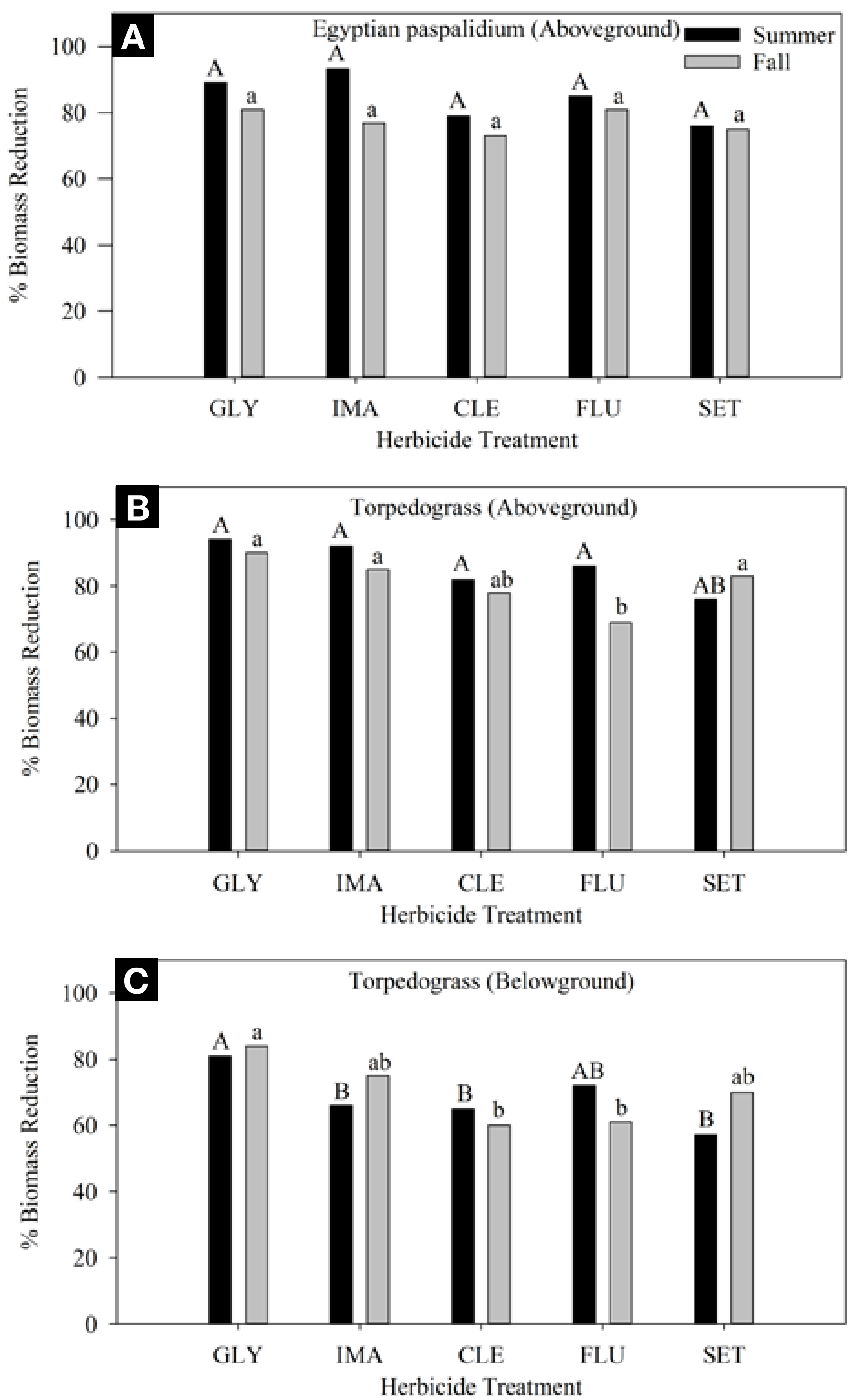
For the Poaceae species, the selectivity for the graminicides would not necessarily be expected between the native and exotic and that was the case. All herbicide treatments severely injured the native Egyptian paspalidium and the exotic torpedograss. For Egyptian paspalidium, all herbicide treatments reduced shoot biomass by 73 to 93% and were not different (Figure 2A). For torpedograss, all summer herbicide treatments reduced aboveground biomass by 76 to 94% and were not different (Figure 2B). However, for the fall timing, glyphosate, imazapyr, clethodim, and sethoxydim reduced shoot biomass by 78 to 90% and were not different. Fluazifop reduced biomass by 69% and was not different from clethodim (78%).

Interestingly, belowground biomass reductions for torpedograss were differ-

The simple translation is this: all three grass-selective products performed similarly with a complete lack of impact to native (non-grass) emergent aquatic vegetation.

Figure 2. Percent biomass reduction of native Egyptian paspalidium (above ground) (A) and torpedograss (above and belowground) (B and C) at eight weeks following foliar application of glyphosate (GLY), imazapyr (IMA), clethodim (CLE), fluazifop-p-butyl (FLU), and sethoxydim (SET). Summer and fall treatments were applied on June 3 and October 3, respectively. Data represent a percent reduction compared to the biomass of the non-treated control plants harvested at 8 weeks. Each bar represents the average of three replicates and different letters above bars indicate differences between treatments (within summer and fall).

ent between herbicide treatments for the summer and fall timings. For the summer timing, glyphosate actually reduced belowground biomass to a greater extent than imazapyr, clethodim and sethoxydim (Figure 2C). Additionally, there were no differences between any of the graminicides or imazapyr. For the fall timing, glyphosate reduced belowground biomass to a greater extent than clethodim and fluazifop. Again, there were no differences between any of the graminicides or imazapyr. The difference between the summer and fall treatments appeared to be largely driven by variation in the performance of two of the graminicides, sethoxydim and fluazifop. Additional studies are currently being conducted to examine this potential issue in greater detail.



These results, recently published in the *Journal of Aquatic Plant Management*, are the first to demonstrate that these three graminicides exhibit a complete lack of activity on several key native non-grass monocots. These results are highly encouraging and have provided an impetus to move forward with additional studies. The selectivity demonstrated in this work suggests that future research should study ways to maximize efficacy on invasive aquatic grasses of interest across multiple sites with differing environmental conditions. Additional selectivity research across a broader spectrum of monocots including other native grasses such as maidencane (*Panicum hemitomon*) would also be useful and is currently ongoing. Data from this work has supported the approval of two Florida Experimental Use Permits (EUP) for sethoxydim and fluazifop-p-butyl, and subsequent registration of sethoxydim (TIGR herbicide) with a 24(c) supplemental label for aquatic use in Florida. The EUPs have allowed the recent initiation of field testing for efficacy and selectivity at a wide range of locations throughout Florida.

This article was condensed from the original journal article: Enloe SF and Netherland MD. 2017. *Evaluation of Three Grass-Specific Herbicides on Torpedograss and Seven Non-target Native Aquatic Plants.* J. Aquatic Plant Manage. 55:58-64. Please refer to this article for full details at www.apms.org.

The work described in this paper was funded by the US Army Corps of Engineers, Engineer Research and Development Center (ERDC), Aquatic Plant Control Research Program (APCRP) and the Florida Fish and Wildlife Conservation Commission, Invasive Plant Management Section.

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How Does Hydrilla Grow?

By Jeffrey D. Schardt and Michael D. Netherland

This photograph exhibits the incredible growth potential of hydrilla, showing the tremendous biomass in the upper two feet of water. Note the profuse branching and lateral growth as it reaches the surface, creating a mat from what is likely a single hydrilla plant. Dr. Bill Haller reported long ago that hydrilla shoot tips can elongate 1 to 2 inches per day which can give the impression that the plant increases by 1 to 2 inches in height. However, *if each of these ~200 apical shoots grows 1-2 inches per day*, this would suggest 200 to 400 inches of total growth per day. Now think about 100 or 1000 of these patches growing in unison from sprouted tubers in a given acre. The time to fill the water column with biomass under high rates of growth is surprisingly short. This picture helps illustrate the story. *Photo taken by Vic Ramey, UF/IFAS Center for Aquatic & Invasive Plants, in 1999.*

	Lateral Branches	New Stems	Stolons
Week 1	2 ± 2	2 ± 0	0 ± 0
Week 2	13 ± 6	6 ± 1	1 ± 1
Week 3	43 ± 11	34 ± 13	3 ± 2
Week 4	129 ± 29	71 ± 16	9 ± 6
Week 5	157 ± 38	190 ± 63	35 ± 20

Excerpt from Table 1. Number of lateral branches, new stems and stolons (± SE) produced by Hydrilla.

Paraphrased from full article: In terms of answering the question of whether hydrilla grows an inch a day, the current results would paint a more complex picture that suggests the initial 10 cm (~ 4 inch) shoot was extending both vertically and horizontally by up to 191 inches per day by week 5 of the study. While growth of individual shoots may be closer to the 1 to 2 inches per day commonly cited, hydrilla was producing numerous stolons and lateral stems that resulted in a rapid three dimensional or radial expansion from the original single 10 cm shoot. While the shoot expansion rates reported would slow greatly as hydrilla formed a canopy and carrying capacity was reached, this study demonstrates that following a short initial lag, hydrilla growth increased rapidly, and the production of numerous laterals stems and stolons help to explain radial expansion as a key invasive trait. While measuring stem extension is quite labor intensive, this type of data provides a unique look at the phenomenal expansion rate of hydrilla.

To read more about this phenomenon, see *Glomski, LM, Netherland, MD. 2012. Does hydrilla grow an inch per day? Measuring short-term changes in shoot length to describe invasive potential. J. Aquatic Plant Manage. 50:54-57.*

Jeffrey Schardt (Jeff.Schardt@gmail.com) is retired from the Florida Fish & Wildlife Conservation Commission – Invasive Plant Management Section in Tallahassee, FL.

Michael Netherland (mdnether@ufl.edu) is a Research Biologist with the US Army ERDC and a Courtesy Associate Professor at the University of Florida, Gainesville, FL.

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FAPMS Embarks on Strategic Planning to Make Your Society the Best It Can Be

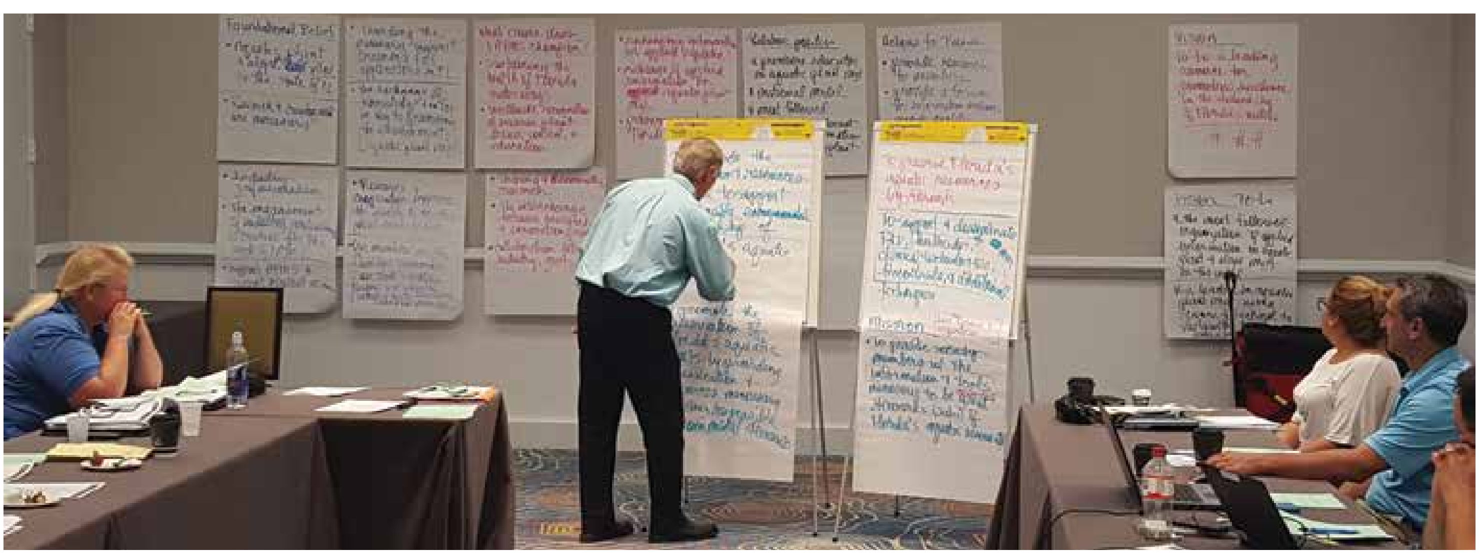
By Andy Fuhrman

On October 16, 2017 the FAPMS Board of Directors and several past presidents spent the better part of a day participating in a strategic planning session at the Hilton Lake Buena Vista Palace. The session was facilitated by Dr. Ed Osborne from the University of Florida's Agricultural Education and Communication Department. The goal was to identify areas of strengths and weakness, update the mission and vison statements, and formulate a plan to improve the society for the future.

Many excellent thoughts and ideas were shared and the group was asked to vote on four of the goals they felt were most significant at this time. The group decided to focus on assisting plant managers in responding to questions from the public, developing a recurring process for engaging with legislators, creating meaningful endorsement/recognition for active members of the society and increasing student involvement in the society and annual conference.

At the next Board of Directors meeting, these goals will be assigned to specific people who will spearhead the efforts. The membership will be updated as progress occurs. The board is working hard to make FAPMS the best it can be to serve its members. Please let any of us know if you have ideas to bring to the table.

Andy Fuhrman, Past-President (afuhrman@allstatemanagement.com), 954-382-9766



41st ANNUAL FAPMS TRAINING CONFERENCE

The 41st Annual FAPMS Training Conference took place in Lake Buena Vista this year and was a big success with just under 300 attendees and 30 vendors. **Ms. Kris Campbell** assembled an exceptional roster of speakers and was able to garner a maximum of 17.5 CEUs per person.

Mr. Mark Hoyer from the University of Florida gave the keynote presentation: *Improving Communication/Cooperation Among Aquatic Professional Societies*, in particular addressing the Aquatic Plant Management Society, the North American Lake Management Society and the American Fisheries Society. This was followed by 32 oral presentations, including 4 aquatic plant manager presentations in a competition for 1st, 2nd and 3rd place. There were also 10 label and product updates from professionals representing their products. An Equipment Demonstration was held concurrently with a presentation on *Public Speaking Methods and Motivation* by Stephen "Monty" Montgomery, an effort to encourage more aquatic plant manager presentations in the future. Public speaking can be nerve wracking and we applaud the 4 presenters this year!

2017 PRESIDENT'S AWARDS

President Andy Fuhrman selected three individuals for the **President's Awards**. Following are the members recognized and the text inscribed on each of their plaques.

Keshav Setaram, SFWMD -Kissimmee Field Station – *In recognition of your career in aquatic plant management. In addition, you are recognized for your vital roles within the Florida Aquatic Plant Management Society. Your ability to hold numerous positions is priceless and why the society is a success.* Keshav served as FAPMS President in 2005. He chaired the Scholarship Foundation for 5 years (2012-2017) and continues to do so, served as Treasurer for 1 year (1997-1998), was a Director at Large (for more than one stint), and continues to chair the Auditing Committee after 15 years (2002-2017)! He will be retiring after a long career with the South Florida Water Management District on December 28th, 2017, but plans to continue serving FAPMS.

Steve Weinsier, Allstate Resource Management, Inc. – *In recognition of your lifetime of passion and commitment to this industry. Your love and fervor for this industry is un-paralleled and you are recognized for continuing to promote the importance of aquatic plant management.* Steve served as FAPMS President in 2004, served as Treasurer for 3 years (1998-2001), and has served the Society in many other capacities over the years.

Karen Brown, University of Florida/ IFAS Center for Aquatic & Invasive Plants – *In recognition of your outstanding service to the Florida Aquatic Plant Management Society and aquatic industry. Your tireless work on several societies and education ventures are vital to the success of the society and industry. You have left a very positive footprint over the course of your career.* Karen served on the Board of Directors from 2011 – 2013 and this is her 10th issue as Editor of *Aquatics*. She will be retiring from the University of Florida's Center for Aquatic & Invasive Plants in 2018.

AQUATIC PLANT MANAGER PRESENTATION WINNERS

This year we had an astonishing 4 brave souls in the **Aquatic Plant Manager Presentation Competition**. Presenters received an initial $100 for participating in the competition. In addition, winners also took home $300 for 1st place, $200 for 2nd place, and $100 for 3rd place. Congratulations, presenters!

1ST Place – Shawn Moore: *"Johnson Grass control in Spartina planting."* Shawn has over 28 years of service with the St. Johns River Water Management District, 22 years as an Invasive Plant Technician. He has performed numerous field trials on new and repurposed herbicide formulations for industry agencies as well as herbicide companies.

2ND Place – Jeremy Ford: *"An inside look at Lee County Hyacinth Control District's Aquatic Plant Management Program."* Jeremy is a native Floridian and has been an aquatic plant manager for over 20 years with Lee County Hyacinth Control District. His expansive knowledge in aquatic plant species, herbicide usage and equipment qualifies him as an expert in the aquatic plant management field. He continues to test new product mixtures and application methods to improve their program and the overall industry.

3rd Place – Marshall Snyder: *"What to do when the CORE dings you."* Marshall has been with the St. Johns River Water Management District for 12 years performing aquatic and upland invasive plant management. In addition to normal duties, he performs wildfire suppression and is a certified aerial ignition operator.

Enjoying the banquet

AQUATIC PLANT MANAGER OF THE YEAR

Stephen "Monty" Montgomery received the prestigious **Aquatic Plant Manager of the Year** award. Monty has logged 17 years in aquatic plant control including waterway, wetland and upland invasive plant management using herbicides in backpacks, spray boats, and a variety of other methods. He has been responsible for permitting and stocking triploid grass carp. He has operated harvesters for submersed vegetation, performed manual vine removal, and managed Brazilian pepper, Australian pine and melaleuca. He has designed management plans for many communities in south Florida and prescribes and develops management practices and strategies for licensed applicators. He works closely with manufacturers, distributors and local universities on field studies and reregistration projects. He helps design new tank mixes and herbicide combinations to avoid plant resistance to herbicides. He has a BS in Marine Biology from Stockton University in Pomona, New Jersey. He teaches continuing education classes for applicators and property managers and also provides seminars for homeowner associations on aquatic weed control and understanding mitigation. He writes many articles on aquatic plant management for local and state publications. He has been a member of FAPMS for 15 years and is a former FAPMS board member and long-time enthusiastic chair of the Merchandise committee. He has given many applicator presentations and general session presentations at the annual conference and won first place in the Applicator Paper Contest in 2006. He discovered and identified one of the first known *Nymphoides peltata* plants in south Florida and collected specimens that are now vouchered in the University of Florida Herbarium.

Plaques and many thanks were given to outgoing board members **Linda Defree, Kelli Gladding** and **Jeremy Slade**. New board members **Lyn Gettys, Thomas Calhoun, and Jim Harris** were voted in at the annual business meeting and will begin serving as directors at large with the next

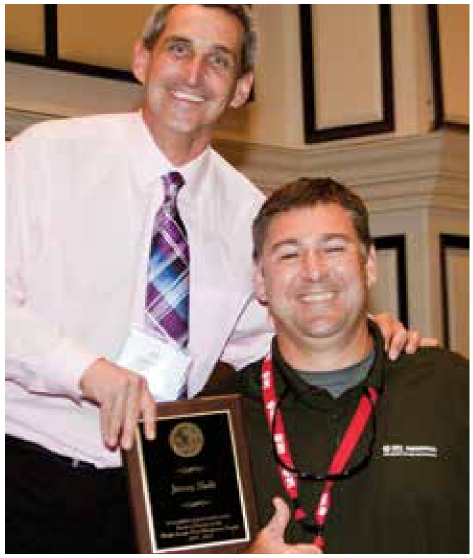
Andy Fuhrman and Linda Defree

board meeting. **Kelli Gladding** will begin serving as President-Elect.

Duck races were popular as usual with **Jeremy Ford, Daniel Pitts** and **Alex Dew** placing 1st, 2nd and 3rd place respectively in the Outdoor category. **William Garrison, Keith Mangus** and **Kevin Klukowski** placed similarly in the Aquatic category. A huge thanks to **Mr. Bill Torres** for his expert handling of all the business involved in holding a 300 person conference year after year. He does a flawless job and we could not do it without him! Be sure to put the FAPMS Annual Conference on your calendar for next year when we will meet in Daytona Beach October 15th-18th, 2018. In 2019 we will be moving to St. Petersburg, then back to Daytona in 2020.

See you all next year!

Andy Fuhrman and Kelli Gladding, outgoing director; incoming President-elect



Andy Fuhrman and Jeremy Slade

William Garrison, Keith Mangus and Kevin Klukowski win big in the Aquatic category.

Jeremy Ford, Daniel Pitts and Alex Dew win big in the Outdoor category.

Jerry Renney, Master of Ceremonies.

Tina Bond gets in the spirit with help from James Boggs and Tim McDuffie.

FAPMS PHOTO CONTEST WINNERS

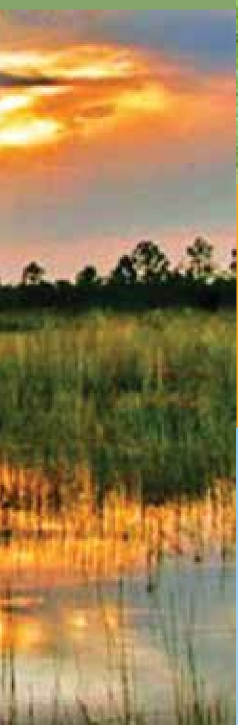
THIS YEAR'S WINNERS OF THE ANNUAL VIC RAMEY PHOTO CONTEST WERE AWARDED CASH PRIZES FOR THEIR WINNING PHOTOS. WINNERS TOOK HOME $150 FOR 1ST PLACE, $100 FOR 2ND PLACE, AND $50 FOR 3RD PLACE IN EACH CATEGORY. CONGRATULATIONS, PHOTOGRAPHERS!

Aquatic Scenes:

1ST PLACE – "EAST MARSH, INDIAN RIVER, C-17" BY JOYCE HERTEL, FELLSMERE WATER CONTROL DISTRICT. JHERTEL60@YAHOO.COM

2ND PLACE – "RING-NECKED DUCK" BY DAN NIEMI, ALLSTATE RESOURCE MANAGEMENT. TAKEN IN PINECREST, FLORIDA, FEBRUARY 21, 2017.

3RD PLACE – "STANDING TALL AND HOLDING GROUND AMONGST THE INVASIVES" BY JEFF HOLLAND, REEDY CREEK IMPROVEMENT DISTRICT. TAKEN IN THE AMERICAN LOTUS FIELDS OF LAKE OKEECHOBEE. JHOLLAND@RCID.ORG



Aquatic Operations:

1ST PLACE – "YOU CAN'T ALWAYS SEE US FROM THE ROAD" BY STEVE NUTTER, SFWMD. TAKEN AT TEN MILE CREEK RESERVOIR, FORT PIERCE. RNUTTER@SFWMD.GOV

2ND PLACE – "LIFT-OFF" BY JEREMY SLADE, UPI. TAKEN MARCH 2, 2017 DURING AN AQUATHOL K APPLICATION IN GOBLET'S COVE ON LAKE TOHOPEKALIGA FOR HYDRILLA MANAGEMENT. APPLICATOR WAS COASTAL AIR SERVICES, INC. JEREMY.SLADE@UNIPHOS.COM

3RD PLACE – "BOSS MAN IN A BUCKET" (INDIAN RIVER COUNTY) BY JOYCE HERTEL, FELLSMERE WATER CONTROL DISTRICT. RODNEY TILLMAN WITH FELLSMERE WATER CONTROL DISTRICT MEASURING A CLOGGED CULVERT. SEE COVER PHOTO

Investigating a Potential Link Between Island Apple Snails and Declines of Kissimmee Grass

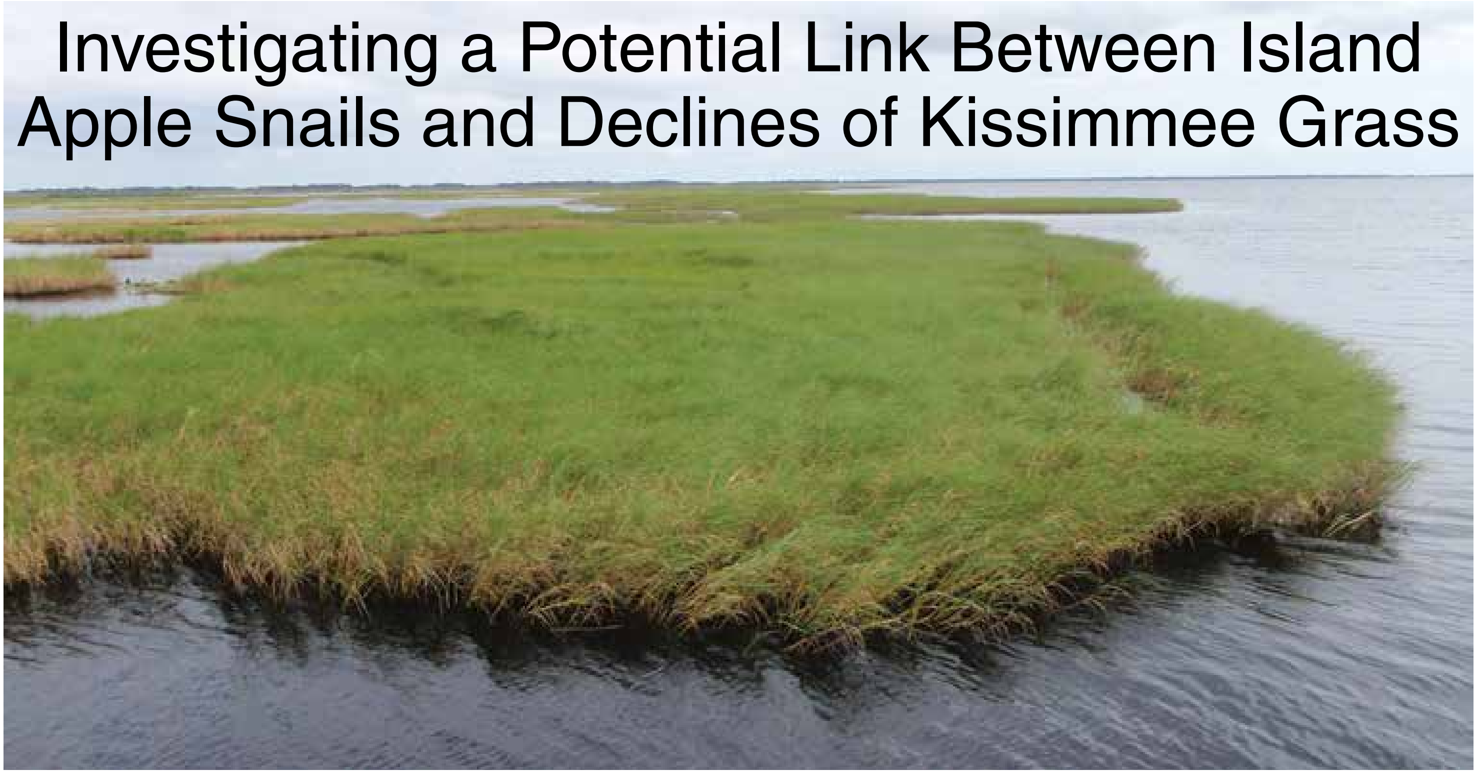


Figure 1A. *Paspalidium geminatum* on Lake Kissimmee in 2009 (Photo by Dean Jones)

By Bill Haller, Mike Netherland, Dean Jones and Jacob Thayer

Over the past few years, beds of native Kissimmee grass (KG), also known as Egyptian paspalidium (*Paspalidium geminatum*), have undergone significant thinning, loss of vigor, and in some cases have disappeared on the Kissimmee Chain of Lakes. The photos in Figure 1A and 1B were taken from the same GPS location in Lake Kissimmee by Dean Jones. The first photo (November 2009) was taken prior to the appearance of island apple snails (IAS) (*Pomacea maculata*) in Lake Kissimmee and the February 2016 photo was taken 3 – 5 years after numerous IAS egg masses were observed. A similar trend of reduced health and abundance of KG was noted on Lake Jackson and Lake Tohopekaliga (Lake Toho) a couple of years earlier in concurrence with observations of dense egg masses of IAS on the emergent vegetation. The loss of KG has been blamed on high or low water, herbicide spraying, accumulation of sediment organic matter, competition from plants such as *Nuphar* or hydrilla, disease, insects, or possibly IAS. Bottom line – we have noted a major decline in abundance of an important native grass, but have not been able to determine a causative factor or factors. In many cases the footprint of the original grass bed can remain intact for years, but the plants are in generally poor health and the stem density is greatly reduced.

With funding provided by the FWC Invasive Species Management Section research program, we started a research effort to evaluate several of the potential factors that could be related to Kissimmee grass declines. We are two seasons into this effort and our results do not support disease, herbicide spraying (including multiple events), or sediment composition/organic matter as likely causative factors. When we bring unhealthy specimens of KG from Lake Kissimmee back to our facilities at the UF Center for Aquatic and Invasive Plants (CAIP), they respond very favorably to culture conditions and we have large healthy specimens within a matter of weeks. Two years of evaluations of herbicide applications were performed, both at the mesocosm scale and field scale (on Lake Pierce), using several of the most commonly used herbicides and herbicide mixtures for maintenance control of floating plants. These treatments generally resulted in temporary browning of the grass followed by recovery within two to three weeks.

We also evaluated the effects of multiple herbicide applications and the same pattern of temporary browning followed by rapid recovery was observed. Collections of field sediments from Lake Kissimmee with the KG in poor condition and from nearby Lake Pierce with the KG in good condition show no evidence of differences in sediment composition or nutrition that would explain the observed differences in plant health between these nearby lakes. In mesocosm trials, KG grew best in a sandy sediment with higher fertilizer levels, but was also quite healthy in sediments amended with organic matter up to 30%. One clear difference noted between Lake Pierce and Lake Kissimmee was the abundance of IAS on Lake Kissimmee versus the lack of any observable IAS or egg masses on Lake Pierce. Therefore we decided to evaluate the potential impact of IAS on growth of KG.

In April 2017, several egg clutches of IAS were collected from Lake Kissimmee. We placed them in tanks in a greenhouse at the CAIP. The snails were fed exclusively on hydrilla collected from CAIP ponds

Figure 1B. *Paspalidium geminatum* on Lake Kissimmee in 2016 (Photo by Dean Jones)

and by September had grown to between 30 to 40 grams each. Kissimmee grass was established in May 2016 by planting several stem sections in 12-qt plastic dishpans with a 1:1 mix of sand and potting soil, plus some fertilizer. By September, the KG had grown to 30 to 35 inches tall and was also producing new shoots from the rhizomes emerging from the soil in the dishpans.

Four fiberglass tanks (72" long, 30" deep and 30" wide) were divided in half with a plastic screen and filled with water to a depth of 18". Two dishpans of KG were placed in each end of the tanks. Ten IAS were placed in one end of each tank separated by the screen from the control plants at the other end of the tanks. Ten IAS per treatment provided a stocking rate of 14.7 snails/m^2. This is likely a high stocking rate but we wanted to determine quickly if the IAS would actually consume KG in this "no choice" study. They quickly consumed the KG and we terminated the study after 19 days.

The plants in tank 2 containing the snails are shown in Figures 2A and 2B before and 19 days after stocking. Results from the other 3 tanks were more variable but showed similar results. Clearly, IAS consumed KG and we observed or measured the following:

1. IAS were seen chewing and breaking the smaller stems of the larger plants at about mid-depth (9") which then floated and were eaten by the snails. IAS do not feed above the water line. The older mature stems persisted but there was no replacement growth. This resulted in reduced health and abundance of older emergent leaves.
2. New underwater shoots were fed upon from the top down to the soil level.
3. The IAS gained weight over the 19 day trial (Table 1). At stocking, the weight of the 10 snails in each tank was 346 grams and, 19 days later, 388 grams for an average weight gain for 10 snails of 43 grams (4.3 grams each).
4. The average dry weight of KG controls

Figure 2A. The plants in tank 2 before stocking with IAS.

Figure 2B. Plants in tank 2 19 days after stocking with IAS.

at 19 days was 86 grams per 2 pans and those exposed to IAS was 29 grams per 2 pans for a 66% decrease in plant dry weight (Table 1).

5. Plants with stems over 5 mm in diameter were generally avoided by these snails.

While there are multiple limitations to this initial study, it is the first trial that has produced results that are consistent with our observations from the field. We have much work left to do with snail densities, duration of the studies, choice tests (e.g. hydrilla vs. KG), but this initial evidence is compelling and suggests that this represents a productive line of research.

Additional anecdotal information is interesting. Eric Crawford (SFWMD) has worked with IAS and concluded that they will east most anything green in the water. Keith Mangus (Applied Aquatic Management) indicated that, on occasion, he has noted large rafts of KG stems sheared off and floating in West Lake Toho. This information does not prove IAS are causing KG decline but consider this. If you have a 500 acre infestation of hydrilla that contains or is near 50 to 100 acres of KG and you (or the snails) control this hydrilla, what is going to happen to the 50 to 100 acres of KG?

This may represent a situation that does not have a management solution. Our objective is to determine a causative factor for the wide-scale decline in native KG abundance. If it is due to IAS, then resource managers will have to take this into account when factoring in impacts on endangered snail kites, hydrilla control, and the potential costs of taking no action.

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Dr. Mike Netherland (mdnether@ufl.edu) is with the US Army ERDC with a courtesy appointment at the UF/IFAS CAIP.

Dean Jones (kdjones@ufl.edu) is a Senior Biological Scientist and Jacob Thayer is an assistant, both at the UF/IFAS CAIP.

Table 1. Dry weight (g) of control pans and those exposed to 10 *Pomacea maculata* snails at 19 DAT. Initial weight of 10 snails and 19 days after a "no choice" feeding study on Kissimmee grass. Tanks (980 liter) were divided in the middle with control plants on one end and snails stocked in the other end. See text for details. Each tank was considered a replication.

	Kissimmee grass (g dry wt)			10 snails (g total)		
Tank	Control	Snail	% Red.	Initial	Final	Change (g)
1	86.7	18.5	78.7	352	412	60
2	84.4	39.4	53.3	341	390	51
3	97.4	22.3	77.1	344	370	26
4	75.9	35.6	53.1	347	378	31
Mean	86.1	29.0	65.6	346	388	43
SD	7.7	8.8	12.4	4.6	18.2	16.1

Women of Aquatics

By Amy Kay

Women of Aquatics (WOA) was established in 2015. Our Mission: *Together we promote all women of the aquatics industry by inspiring and supporting them to pursue their ambitions and achieve their potential both professionally and personally.*

Areas of focus include career advancement, continuing education, work-life balance, and health & wellness. WOA became a non-profit organization in March 2017.

A primary goal is to have a WOA meeting at each Aquatic Plant Management Society (APMS) chapter conference to increase participation, retention and growth within the organizations and our industry as a whole. Meetings were held this year at NEAPMS, MAPMS, WAPMS, Wisconsin Lakes Partnership, and FAPMS. This was the first year for NEAPMS and yielded a record turnout of approximately 40 women. The first joint event (women & men), "Get on Board with Women of Aquatics," was held at WAPMS this past March. A sponsored happy hour prior to the WAPMS banquet cruise on Lake Coeur d'Alene had approximately 50 attendees. Nearly $400 was raised through a split the pot event and became our first deposit in the WOA checking account. A luncheon was held at FAPMS with 15 women gathering for lunch and discussion.

A Board of Directors has been established with the following officers and directors:

- President: Amy Kay, Clean Lakes
- Vice President: Sue Cruz, Vertex Water Features
- Treasurer: Syndell Parks, Grand Valley State University
- Director: Amy Ferriter, Crop Production Services
- Director: Shannon Junior, SOLitude Lake Management
- Director: Emily Henrigillis, Onterra LLC
- Director: Emily Griffith, Sprayco
- Director: Norma Swann, Alligare
- Director: Lyn Gettys, UFL
- Director: Dehlia Albrecht, UFL

We plan to add a Secretary, Editor and additional directors in the near future. In January 2018 our membership system will be in place; our contact list for future membership is approaching 200. A strategic planning retreat is scheduled for February 2018. A website is in progress, and we have a Facebook page – search Women of Aquatics, or go to www.facebook.com/womenofaquatics.

WOA would like to thank all of our peers, colleagues and the involved APMS chapters who have participated and supported our mission thus far and those who plan to do so as we continue moving forward.

For more information, contact Amy Kay, Clean Lakes, (akay@cleanlakesmidwest.com), (715) 891-6798.

Photo Caption: Pictured from left (back row): Alex Onisko (SFWMD), Kris Campbell (FWC), Rose Godfrey (FISP), Deb Stone (SJRWMD), Sherry Williams (Seminole County), Amy Kay (Clean Lakes), Tina Bond (Helena), Samantha Sardes (UFL and Aquatic Systems); (front row): Jessica Spencer (ACOE), Samantha Yuan (FWC), Kelli Gladding (SePro), Regina Stenberg (Lonza), Rosa Michaelson (Pond Biologics), Dehlia Albrecht (UFL-CAIP), Karen Brown (UFL-CAIP). Not shown: Mandy Andrea (Seminole Tribe), Mariah McInnis (FWC).

Hiding In Plain Sight:

A Toxin Produced by Cyanobacteria is Growing on Invasive Aquatic Plants and Moving Up the Food Chain in Florida Lakes

By Susan B. Wilde, Brigette Haram, Wesley Gerrin, Tabitha Phillips, Dean Jones and Mike Netherland

Mysterious eagle deaths were first reported by fishermen on Thanksgiving Day, 1994 at DeGray Lake, Arkansas. From 1994-1997 during late fall and winter, fifty-five bald eagles and hundreds of coots were found dead or dying at DeGray and other nearby Arkansas lakes. At the time, the US Army Corps of Engineers web site stated that this was the most significant unknown cause of eagle mortality in the history of the United States.

The eagles found alive were neurologically impaired, stumbling on the ground, wobbling in flight, and perched with drooping wings. Sick coots wobbled in flight or couldn't fly at all. They might fall back to the water, or just dive down to avoid an approaching boat. When they did surface, they had difficulty righting themselves. The sickest birds seemed almost blind, did not respond when approached, and were easily caught by researchers and predators.

Veterinarians and pathologists working at the US Geological Survey National Wildlife Health Center found unique brain lesions in impaired eagles and coots during the first outbreak at DeGray Lake and named the disease avian vacuolar myelinopathy (AVM). Nancy Thomas and other scientists described these lesions as open spaces in the white matter of the brain (Thomas, et al 1998). AVM is difficult to diagnose because birds do not always appear impaired even when they have the characteristic brain lesions. Unfortunately, microscopic study of the brain is still the only way to confirm that a bird has AVM and this requires the bird carcass to be collected within 24 hours of dying, with the brain tissue preserved in formalin (not frozen).

When the first birds died in Arkansas, researchers investigated all known potential sources of mortality. They examined different organs for other abnormalities but found none. Some of the birds were in fairly good body condition. Many coots seemed to have been eating right before they died. No infectious disease agents or known toxins were found.

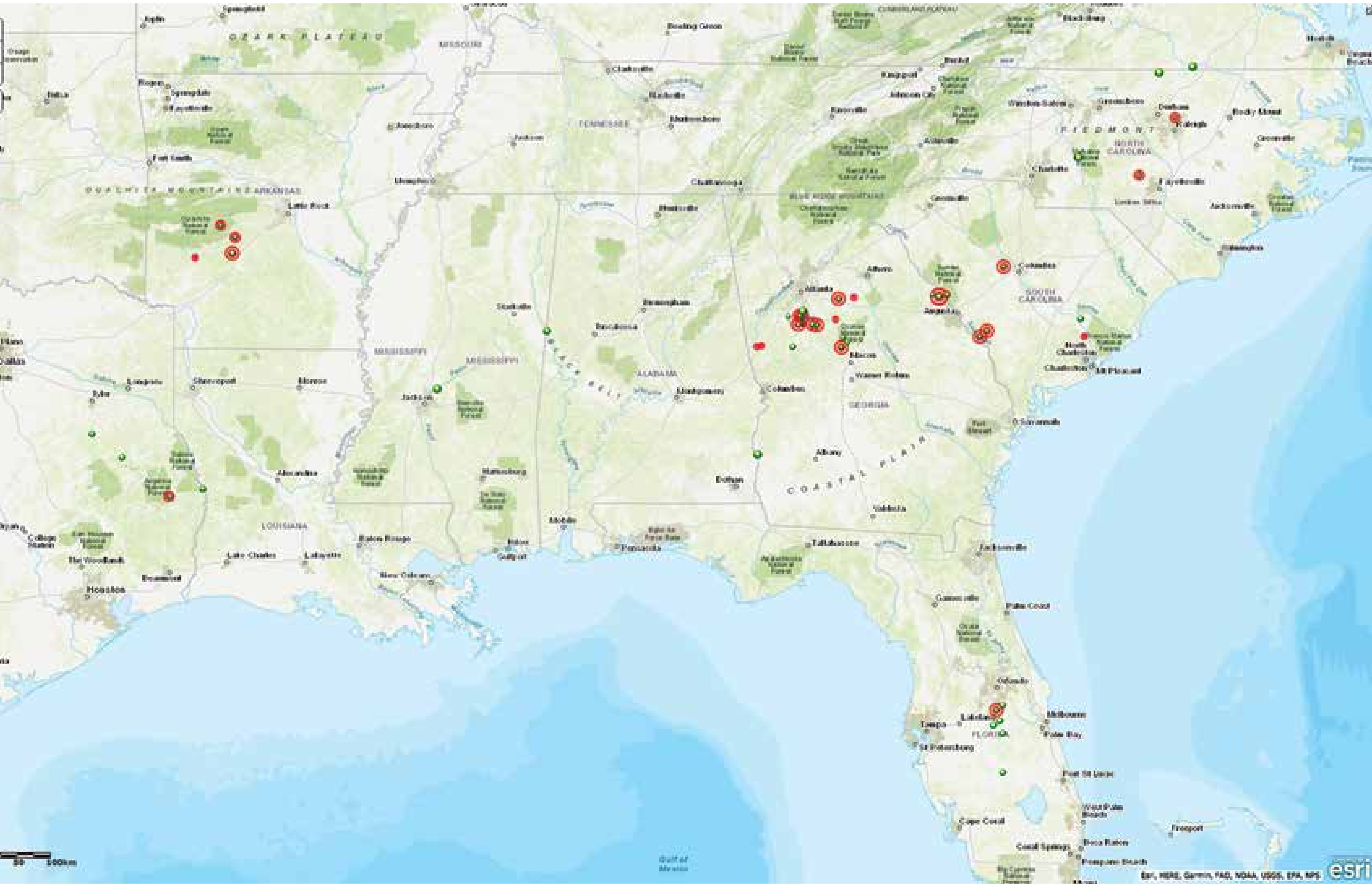
What investigators did find was that all known AVM sites (sites where birds were dying and had unique AVM brain lesions) had certain things in common: they were constructed ponds or constructed reservoirs with low to moderate nutrients, dense growths of non-native aquatic plants, but no harmful algal blooms.

AVM is site specific. Healthy birds arrive at a site and become exposed to the toxin

A. hydrillicola growing on hydrilla leaflets produces biotoxin

Exotic apple snails feed on hydrilla and accumulate biotoxin

Snail kites feed on exotic snails and ingest biotoxin



Expanding locations – AVM reservoirs in 2017.

166 eagles – AVM confirmed birds

30 sites (including 7 in FL) Hydrilla & *Aetokthonos hydrillicola*

20 sites – AVM+, Hydrilla & *A. hydrillicola*

through the food chain. Other waterfowl also documented with the same brain lesions include those that consume a lot of plants—Ring-necked ducks, Buffleheads, American wigeons; ducks that eat plants as well as other items—mallards, geese, and their predators. A Great Horned Owl and Killdeer were also found with AVM lesions at Thurmond Reservoir (Fischer, et al 2002).

Our team began conducting aquatic plant and harmful algae surveys in 2001. All AVM sites (where birds have AVM lesions) have dense stands of non-native submersed plants. There were ten sites and nine of those were dominated by *Hydrilla verticillata*. We also found Brazilian elodea (*Egeria densa*) which was the dominant vegetation in DeGray Lake, Arkansas during the first outbreak, and Eurasian watermilfoil (*Myriophyllum spicatum*) in a number of AVM sites.

We also found a new species of cyanobacteria (blue-green bacteria or algae) growing as epiphytes on the invasive aquatic plants, primarily on hydrilla, but also on *Egeria*, Eurasian watermilfoil, and even some co-occurring native plants (Wilde, et al 2005). We had not seen this species of cyanobacteria before and spent some time trying to describe its growth pattern and conduct genetic studies to see which known species it was most closely related to.

We initiated feeding trials with hydrilla from reservoirs where we had active disease and where we had documented the novel cyanobacteria, and with hydrilla without the novel cyanobacteria from control lakes. From those trials, we were able to recreate the disease in the laboratory but only in Mallards or Chickens that consumed the hydrilla with the novel cyanobacteria (Wiley, et al 2007). The working hypothesis at that point was that we had potentially toxic cyanobacteria on hydrilla and some other aquatic plants at AVM sites. Coots tend to concentrate in reservoirs with abundant aquatic vegetation, especially hydrilla.

We completed the genetic and morphological characterization of this species and, because it is so different from any other described cyanobacteria, it is not only a new species but a new genus. We named it *Aetokthonos hydrillicola* (*Ah*) which translates to "*eagle killer living on hydrilla*" (Wilde, et al 2014).

We now have a total of 30 sites with hydrilla/*Ah* (including 7 new ones from Florida). We suspect there are additional sites at risk for the disease. We have also seen an expansion in the food chain. We know there are additional pathways beyond hydrilla being consumed by coots that are subsequently consumed by eagles. We have documented AVM lesion formation in grass carp, seen toxin transferred through apple snails, and noted some effects on additional herbivorous waterfowl species.

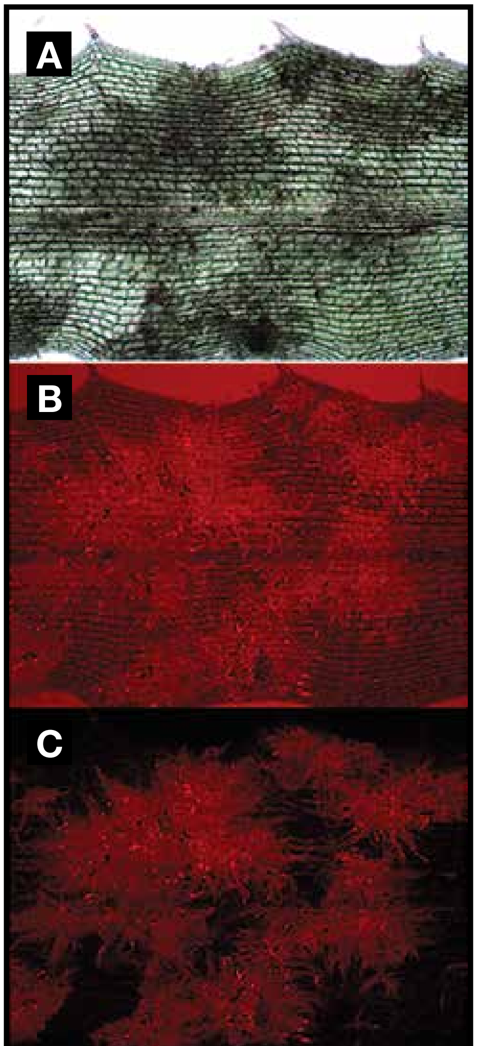
Although we had remaining questions, we wanted to work on management solutions as soon as possible because we felt we had clearly demonstrated that exposure and consumption of the hydrilla complex was dangerous to aquatic organisms. Triploid Chinese grass carp have been used to control hydrilla in other lakes and reservoirs. Grass carp did not die in either laboratory trials or in field exposures where they consumed all of the hydrilla. When these fish were fed to chickens and the chickens did not develop AVM lesions, we demonstrated that while the fish are vulnerable to the toxin and they do develop lesions, it does not appear to kill them; they can still control aquatic vegetation, and they don't appear to transfer the toxin (Haynie, et al 2013).

As we continued to investigate new locations, we were contacted by the Florida Fish and Wildlife Conservation Commission (FFWCC) to investigate whether Eagles and Snail Kites might be at risk in Florida. The Snail Kite is classified as endangered in Florida and consumes apple snails almost exclusively. They have switched from the native apple snails (*Pomacea paludosa*) to the larger invasive island apple snails (*Pomacea maculata*) since they have invaded these new locations. Lake Tohopekaliga (Lake Toho) is one location with extensive hydrilla beds that support the invasive snail and where Snail Kites are nesting. An upper cove of Lake Toho is one of the first locations in Florida where we found the *Ah* cyanobacteria growing fairly densely on hydrilla. This is a critical Snail Kite nesting area so we collected data to see if the hydrilla/*Ah* matrix was toxic at this location. We fed the hydrilla/*Ah* collected from Toho and fed it to chickens and they developed AVM brain lesions. We also wanted to determine whether or not the invasive apple snail would transfer the toxin up the food chain to bird predators as apple snails consume a lot of hydrilla. We fed toxic hydrilla/*Ah* collected from Lake Thurmond and control hydrilla material without the toxic cyanobacteria to apple snails. We then fed those potentially toxic snails to 10 chickens and confirmed that these birds also developed AVM lesions. We also found lesions in five of the ten coots collected from the region of Lake Toho where we documented hydrilla/*Ah* (Dodd, et al 2016).

We now have a total of 30 sites with hydrilla/Ah (including 7 new ones from Florida).

This demonstrated that Snail Kites could indeed be at risk of contracting AVM because the toxins can transfer through the food chain from hydrilla to the invasive apple snails. This may also be true with the native apple snails but the invasive snails are much larger, more abundant, reproduce very rapidly, and consume large amounts of hydrilla.

Surveys conducted in January 2015 documented *Ah* cyanobacteria growing in East Lake Toho, and down the Kissimmee



A. Transmitted Light

B. Transmitted & Epifluorescent

C. Epifluorescent light

Autofluorescent *Aetokthonos hydrillicola* colonies growing on the underside of a hydrilla leaf. Using a compound microscope, 400X magnification and epifluorescent filter sets, we can see large dark blue-green colonies under (A) standard transmitted light illumination. Once we turn on the top lighting with only the green wavelengths of light, we see the phycocyanin pigments of the cyanobacteria shine bright red (B) transmitted light and epifluorescent lighting with green band of light, and (C) only epiflourescent (top) light.

Florida Snail Kite with apple snail. Photo by Mac Stone (macstonephoto.com)

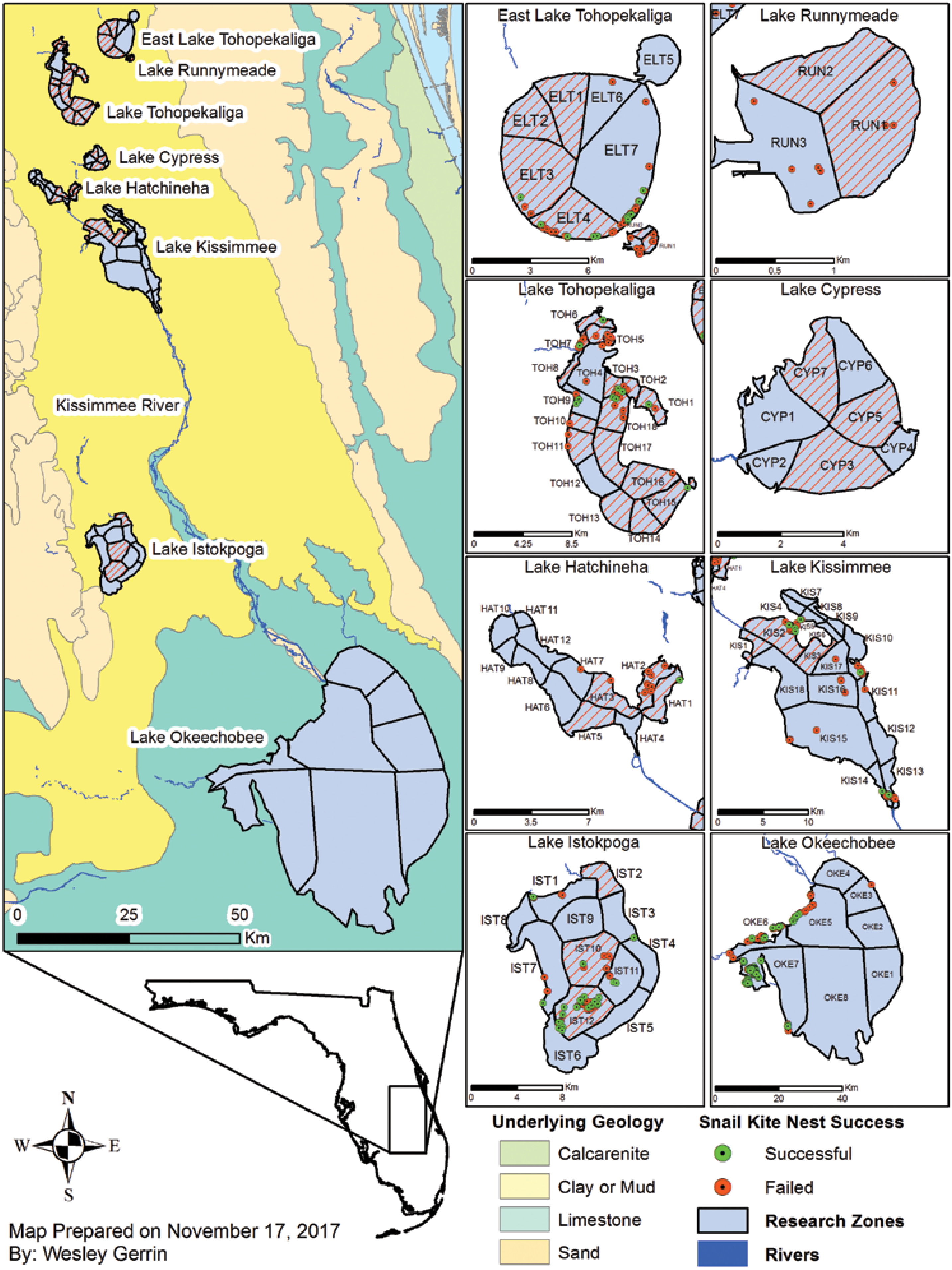
Chain of Lakes in Kissimmee, Cypress, and Hatchineha. These findings reveal a new area where the disease had not been previously documented. In all of those locations, we found at least one cove, and sometimes several coves, with fairly dense colonization by the toxic *Ah* cyanobacteria. East Lake Toho had the highest number of additional aquatic plant species with *Ah* colonies. Return visits to these locations in 2016-2017 yielded similar results. We found moderate-high densities of *Ah* in Lake Toho and Lake Istokpoga, but none in Lake Okeechobee. Data also revealed additional positive sites within other Kissimmee Chain lakes where *Ah* had never been found. We plan to continue our monitoring efforts into 2018, so that we may hopefully gain a better understanding of the extent of the range of *Ah* in these lakes.

Many factors are known to affect snail kite nesting success; the map illustrates nest failures within zones where we have confirmed the presence of *Ah*. We will continue to monitor for *Ah* toxicity in areas where kites are nesting to investigate whether this cyanobacterial epiphyte presents additional risk to the Florida Snail Kite. In addition, the map illustrates a potential connection between the underlying geology of a lake and the growth of *Ah*. One current hypothesis is that the soil and water conditions created by limestone geology, as is found in Lake Okeechobee, are not ideal for *Ah*, whereas the opposite is true for the clay-rich geology present in the Kissimmee Chain of Lakes. We have also noted that the spike in toxicity occurs in late fall. It is important that we maintain monitoring for the sake of the birds but also for the clues it provides us in knowing which environmental conditions are conducive to toxin production.

Since we have now observed *Ah* on some native aquatic plant species, we will determine whether there is toxin produced and if AVM can result from wildlife consuming native species. And finally, we all want to know if there is a risk to human health. We need to further investigate whether there is concern for fishermen, waterfowl hunters or drinking water in these locations.

Note: Please help us evaluate more sites by sending plant samples to screen for the cyanobacterial species associated with AVM sites. Contact the author for the plant collection protocol, field data collection form, and the APHIS permit.

Right: Map shows research zones affected by *Aetokthonos hydrillicola* (red hatching), underlying geology, and snail kite nesting success in the Kissimmee Chain of Lakes, Lake Istokpoga, and Lake Okeechobee, Florida. Snail Kite nesting success data are based on 2016 surveys conducted by the FFWCC and Army Corps of Engineers funded University of Florida Snail Kite crew. These UF graduate students and technicians are led by UF Professor Dr. Robert Fletcher.


East Lake Tohopekaliga
Lake Runnymeade
Lake Tohopekaliga
Lake Cypress
Lake Hatchineha
Lake Kissimmee
Kissimmee River
Lake Istokpoga
Lake Okeechobee
0 25 50 Km
N
W
E
S
Map Prepared on November 17, 2017
By: Wesley Gerrin
Underlying Geology
Calcarenite
Clay or Mud
Limestone
Sand
Snail Kite Nest Success
Successful
Failed
Research Zones
Rivers

Right: Spots on hydrilla indicate epiphytic *Ah* cyanobacteria.

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Dean Jones (kdjones@ufl.edu) is a Senior Biological Scientist and Jacob Thayer is an assistant at the UF/IFAS CAIP.

Calendar of Events 2017 & 2018

January 9 – 11
Northeast Aquatic Plant Management Society (www.neapms.org); Portsmouth, NH

January 21 – 24
Southern Weed Science Society (www.swss.ws); Atlanta, GA

January 22 – 25
Florida Mosquito Control Association Dodd Short Course (www.dodd.floridamosquito.org/Dodd/)
Altamonte Springs, FL

January 29 – February 1
Weed Science Society of America (wssa.net)
Arlington, VA

February 26 – March 1
Midwest Aquatic Plant Management Society (www.mapms.org)
Cleveland, OH

March 26 – 28
Western Aquatic Plant Management Society (wapms.org)
Reno, NV

April 3 – 6
Florida Exotic Pest Plant Council (www.fleppc.org)
Melbourne Beach, FL

April 18 – 20
Florida Vegetation Management Association (www.myfvma.org/)
Daytona Beach, FL

May 7 – 10
UF/IFAS Aquatic Weed Control Short Course
(www.conference.ifas.ufl.edu/aw/)
Coral Springs, FL

July 15 – 18
Aquatic Plant Management Society (www.apms.org)
Buffalo, NY

August 19 – 23
American Fisheries Society (https://fisheries.org/)
Atlantic City, NJ

October 15 – 18
Florida Aquatic Plant Management Society (www.fapms.org)
Daytona Beach, FL

October 30 – November 2
North American Lake Management Society (www.nalms.org)
Cincinnati, OH

FAPMS Scholarship and Research Foundation, Inc.

2017 Paul C. Myers Applicator Dependent Scholarship Awards

The FAPMS Scholarship Foundation was established by the society's Board of Directors and is administered by the FAPMS Scholarship and Research Foundation, Inc. Since 1986 the foundation has provided over $75,000 in scholarships. This year we had a surprising 11 applications for the Paul C. Myers Applicator Dependent Scholarship. Following are the recipients who will receive financial assistance with their college expenses:

- Luke Allen, University of North Florida (member Nancy Allen)
- Alexis Burn, University of Central Florida (member Charles Burn)
- Abigail Campbell, Florida Gulf Coast University (member Robert Campbell)
- Austin Edwards, University of North Florida (member Mark Edwards)
- Abigail Farr, Eckerd College (member, David Farr)
- Emily Jones, Florida Southern College (member Dean Jones)
- Jeremiah Lovestrand, Tallahassee Community College (member Robert Lovestrand)
- Nathan Lovestrand, Pasco Hernando State College (member Robert Lovestrand)
- Kaylie Mangus, Florida Gulf Coast University (member Keith Mangus)
- Adrianna Rose, Florida Southern College (member David Rose)
- Taylor Walters, University of Florida (member Stephanie Walters)

Thank you FAPMS members and sponsors for your support!

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