# Aquatics

SUMMER 2021

A Publication of the Florida Aquatic Plant Management Society

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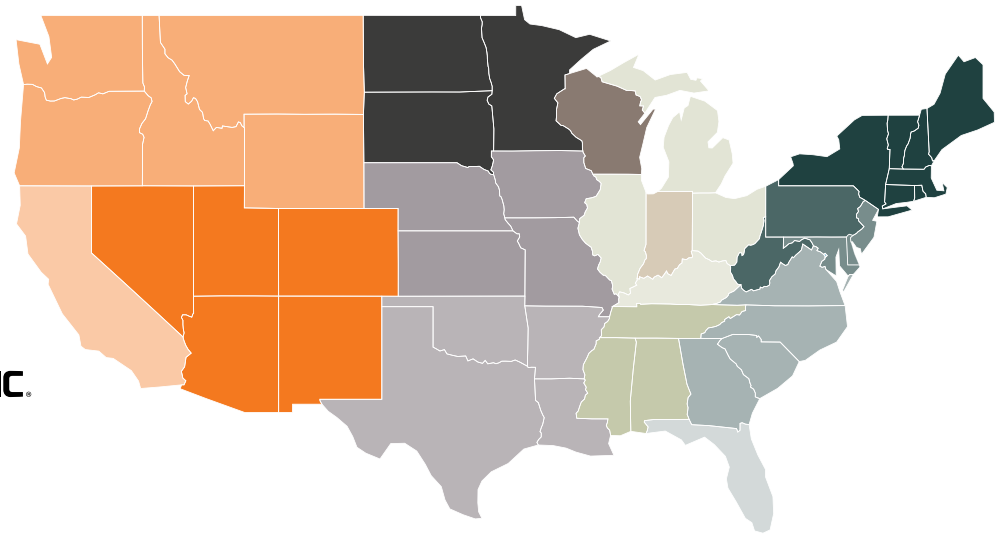

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# Aquatics

SUMMER 2021 Volume 43, Number 2


This great egret (*Ardea alba*) is hunting for lunch among the aquatic plants in the Draa Storm-water Park, Titusville, Florida. Native aquatic vegetation supports the egret's diet, providing frogs, fish, and other small aquatic animals found along fresh and saltwater shorelines.

Photo: Amy L. Giannotti

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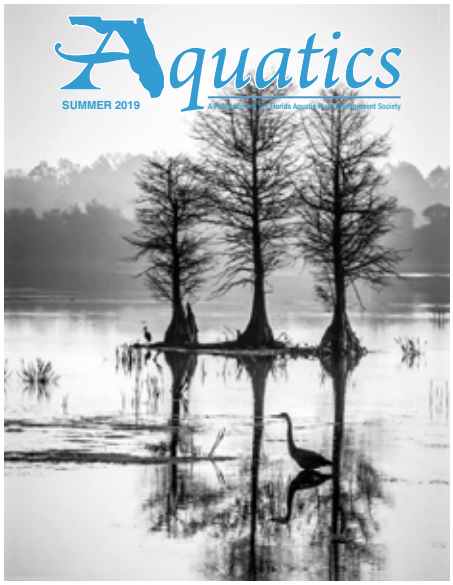
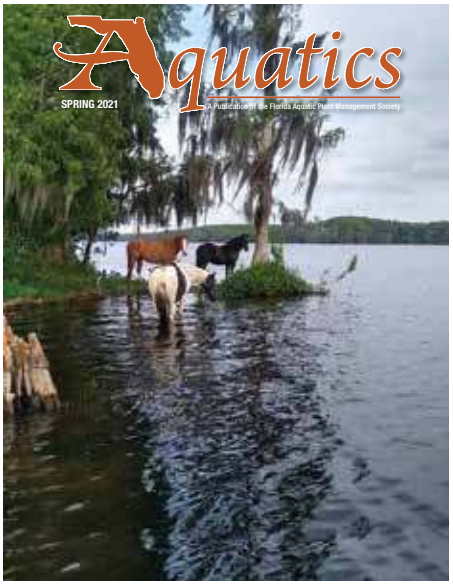
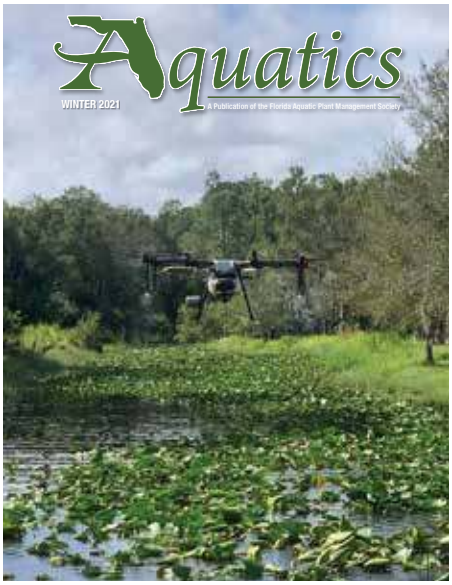
# Reminder about Aquatics Magazine Distribution

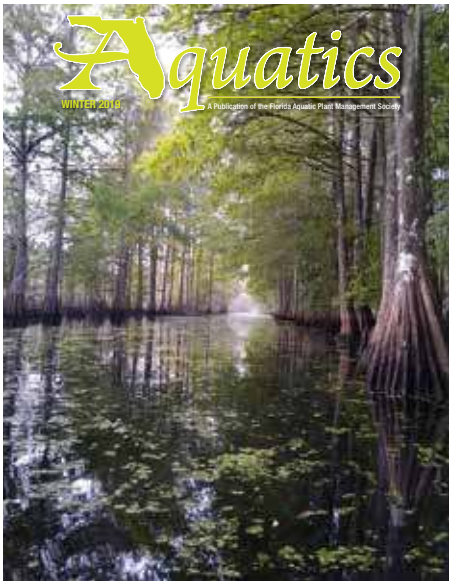
Beginning with the next issue, printed copies of Aquatics magazine will be mailed ONLY to those who have an active membership in the Florida Aquatic Plant Management Society (FAPMS). Those who do not have an active membership may access the publication online at https://fapms.org/publications/aquatics-magazine/issues/, but issues will be uploaded on a two-issue delay.

To become a member of FAPMS or renew your membership, please visit: https://fapms.org/membership/



# CAIP Update

*There is nothing permanent except change – Heraclitus*

The UF/IFAS Center for Aquatic and Invasive Plants has been enjoying a number of great and exciting changes over the past two years. In 2018, due to numerous and overlapping retirements, we had just one faculty member and three staff. But due to the excellent commitment from IFAS administration and support from our numerous stakeholders, we have been able to grow the Center to four faculty members, six staff, and numerous graduate and undergraduate students. This has translated in a general buzz of activity and excitement, the result of which is full greenhouses all over our campus, every mesocosm filled to capacity, and boats being hauled to a different lake almost every day. So, what's next? Well, according to Heraclitus, change.

Shelby O. Thomas was hired as our communications manager in 2019 and immediately transformed our programs. Through her expert leadership and direction, she dramatically increased the reach of our office through social media, print, and video production. Her boundless energy was contagious and led to the entire aquatic community thinking more about positive engagement and communication strategies. But since change is inevitable, Shelby was promoted to a new position within UF a few months ago. Though it was hard to see her leave, it was clearly the best thing for her future.

Fortunately, we were able to refill this position with the incredibly talented and ambitious Raychel Rabon. Raychel has a skillset that is immense, years of practical experience, and a personality that makes everyone an instant friend. We will all have the opportunity to learn from her in the coming months as excellent educational materials continue to flow

Drs. Prince, and Enloe

Raychel Rabon

from the Center. I am excited to see what the future holds. So, maybe it is time for a new quote:

*The more things change, the more they stay the same – Bon Jovi*

Along these lines, you will all remember that Dr. Bill Haller retired in 2018 – and realize I am using the word "retire" very loosely. He continues to work four to six days a week and is still cranking out research. The only thing that hinders his work week is when he is scheduled to take the grandkids to soccer, dance, or some other practice. Although he has been retired for three years, not a lot has changed.

So where is the Center as we pass the half-way point of 2021? We continue to grow and do great things. Drs. Prince, Sperry, Leary, and Enloe are building and expanding their programs each day. Graduate students and interns are having the trajectory of their future careers changed each day. And the excellent work being done and communicated will inevitably be used to improve our understanding of invasive plant management and preservation of native habitat. Although a lot has changed, at the end of the day, the Center has stayed wonderfully the same.

*Dr. Jason Ferrell (jferrell@ufl.edu) is the Director of the Center for Aquatic and Invasive Plants at the University of Florida. Jason leads a multidisciplinary group of faculty and staff whose mission is to develop and disseminate strategies for addressing the impacts of invasive plants. During his tenure at UF, he has published over 100 refereed scientific articles, authored hundreds of extension publications for outreach, led numerous extension meetings, and mentored 19 graduated students.*

Dr. Leary

Dr. Prince

Dr. Sperry

Dr. Jason Ferrell

# SAFETY ON THE WATER:
# Plan Your Float and Float Your Plan

Responsible scuba divers live by the axiom "Plan your dive. Dive your plan." It is generally accepted that working in natural areas—like underwater or on the water—means we accept that we cannot always control what happens to us. Therefore, mitigating some of that risk should happen before we even leave the office.

Our work as natural resource managers involves daily reporting and documentation associated with site inspections, treating/removing invasive plants, monitoring water quality, weather conditions, etc. Probably the single most important piece of documentation for our profession is one that is often overlooked—a float plan. We get so accustomed to our daily routine and what seems to be second nature to us, and that is unfortunately when things can go very wrong very fast. Whether you are on the water for a day of work or spending a week offshore fishing, a float plan can be a lifesaver.

A variety of communication technologies are available today (cell phone, satellite personal trackers, GPS, etc.)—and those are great when they work, when we have service, and when we aren't in distress dealing with an emergency. But nothing takes the place of an organized and detailed float plan filed with a responsible party remaining on shore.

A float plan is a document that contains all the information needed for search and rescue to find you if something should go wrong. Most importantly, a float plan should include at minimum:

- Name of crew and passengers
- Vessel/truck/trailer details – size, color, type, engine, license/tag/registration numbers, etc.
- Work location and expected route to/from site
- Departure time and expected return plans
- Your contact information & contact for responsible party on shore

Other specific details that are helpful to include are:

- Safety equipment on board
- Weather forecast for that area
- Electronics/communication equipment on board

*Before departing for the day, leave a copy of your float plan with a responsible person on shore. This can be a colleague, a family member, your employer, or the local law enforcement office in your region. It should also be standard practice to inspect and assess the condition of all on board safety and communications equipment.*

*Upon returning from your time on the water, it is important to deactivate your float plan by letting the responsible party know you have returned safely. This person/s should also be notified if your time on the water is delayed, you moved to a new area, or your route of travel has changed. Failure to do this may result in an unnecessary search effort being launched.*

*A variety of Float Plan templates exist on the internet, and a sample from the United States Coast Guard is included on page 9.*

*With permission, Duke Energy shared this event that reminds us how critical a float plan is, and we share this to honor the memory of those lost in hopes that it never happens again.*

**Elaine Jones: a 27 year-old Assistant Biologist. She was married with 2 stepchildren. Elaine worked for the company for 5 ½ years and was excited about developing her expertise in benthic ecology. Her body was recovered at 12:15 am on January 8. Somebody had constructed a sling on the bow of the boat and Elaine was in the sling. She had died of exposure.**

**David Wayne Revill: David was a 30 year-old lab technician. He was married and they had just had their first child, a son, about a month before the accident. Wayne had been a sheriff's deputy in eastern North Carolina, but had worked for Duke the last 8 months. Wayne's body was found about 9:00 am on 8 January. He had died of exposure or drowning.**

**Robert Lynn Green: Lynn was a 28 year-old Associate Biologist, and a gifted scientist. He received his MS from Tennessee Tech and was married with no children. Lynn worked for Duke almost 4 years prior to leaving for a Forest Service job in Florida. He didn't work there long before he realized he wanted to return to Duke. He had been back three short weeks prior to the accident. His body was not recovered for approximately 18 agonizing months.**

On January 7, 1980, a Monday, they were all collecting aquatic insects from the bottom of the Lake Norman near the mouth of Davidson Creek. Lynn was filling out a data sheet at a sampling location on Lake Norman. Little did he know it would be one of the last things he ever did. It was not a particularly bad day weather wise, but cold and misty rain was falling. The tasks at hand were to collect insects at various locations on Lake Norman, both out in deep water and in shallow, place the samples in quart bottles, and transport them back to the lab late that afternoon. Not until later that evening, when Wayne's wife called one of our co-workers, did we know they never made it back to the lab.

"Elaine was a dedicated biologist with a keen interest in freshwater worms (oligochaetes). She quickly became our expert on worms in the Benthos Group, an eight-member team in the 80s that were responsible for collecting, identifying, and analyzing aquatic insect populations around

Duke's fossil and nuclear plants. Elaine was the "consummate professional" of the group. Lynn loved caddisflies. He was always excited about collecting trips to the proposed Bad Creek Hydroelectric Station site in the late 70s where there were prolific populations of not only caddisflies, but mayflies and stoneflies in the mountain streams as well. One day, Lynn and I were collecting insect samples over a 24-hour period in one of the feeder streams to Lake Jocassee. I never did much trout fishing so after collecting for much of the day Lynn pulled out his fly rod and decided to catch some brook trout. I had never seen a fisherman get so excited over a five-inch fish in all my life. I must say I gave him a hard time about such small fish. Wayne had only been with the Company eight months before January 7. What I did know of Wayne was that he really appreciated his new job at Duke. He loved to bowl and participated on the Lab bowling team with Jan, James, Reggie and myself. What was also evident about Wayne was his devotion to his firstborn child, a son born one month before the accident."

***This note's intent is to not only remember Elaine, Wayne, and Lynn, but also to inspire YOU to be safe; honor their memory and place safety at the top of your list with everything you do at work and at home. The basis of our boating safety at Duke Energy; our Aquatic Search Guidelines, float plans, aquatic specific procedures, Pre-Job Briefs and Hazard Analysis, float suits, SPOT messenger units, weather awareness, active caring for each teammate; many of the items we use every day in our workplace are all safety improvements we have initiated since this tragic accident.***

As Gene Vaughan (EHS Senior Scientist Emeritus) said in the note below, "January 7 will never be like any other day to many people at the Environmental Center". Elaine, Wayne, and Lynn were great friends and teammates, and we should never forget them or their families. While we will never forget the time we had with Elaine, Wayne, and Lynn, their legacy will be in part, that Duke Energy's safety program is strong and growing because of them. In his 2011 note, Gene stated "that in just a single moment, all that we know cherish and love can vanish; tears and sorrow and increased emphasis on safety can never ever bring it back". Whether in doing a job we've done countless times before or whether this was the first time, in recognizing that a possible safety concern is present or that the job is so simple that it did not even come up in the pre-job safety briefing, in following a procedure to the letter or taking a shortcut to make the job go quicker; the precious gift of life can be gone so quickly. As we commemorate the lives of those lost on this fateful day let us certainly rededicate ourselves to our safety programs, let us continue to be vigilant in identifying safety hazards, and maybe most of all may we look out for each other. The following account of what happened 41 years ago today, written by Dr. Larry Olmsted, is offered as a reminder to all of us and may we pledge to never let it happen again."

A call one dark and cold and breezy night that three of our teammates had not returned from sampling on Lake Norman brought several of you and your staff members to the Environmental Laboratory. A review was made as to where the crew had been sampling and designated portions of the lake were then searched by each team of two. The search team was to frequently call in to Bill Adair at the laboratory to give updates. It was a very different Lake Norman in 1980; little development, large stretches of shoreline without development, and an almost impenetrable darkness with few discernible landmarks. The pattern for the search teams was to motor for a distance, shut the motor off, and yell "Wayne… Lynn…Elaine...." But there was no answer. Every time the search teams yelled there was only a deafening silence. About 12:30 it was reported that the boat had been found; presumably good news everyone thought. Unfortunately, the news was shattered by the devastating information that one body had been found and two were missing. Those weren't just teammates that had been lost, they were friends.

These were experienced people doing a job they had performed numerous times before, under conditions that were not threatening. In spite of intensive investigations, to this day no one knows what went wrong, we know only that they left after lunch and never returned. There was a stunning sense of loss and an overbearing numbness. The 18 months until the recovery of Lynn's body was particularly agonizing, but even the recovery of his body did not bring closure. The emptiness and sense of loss continues for many employees and past employees to this day and it always will. We can't change the past, but we can learn from it. The memory of Elaine, Wayne and Lynn teaches us:

**1. The fact that we have done a task numerous times does not lessen the hazard of the job, but may increase the hazard if we become complacent.**

**2. The safety and welfare our coworkers must remain our top priority.**

**3. We must look beyond safety as a measure or incentive and view it as a process and dedication to the idea that all our coworkers go home at the end of the day as safe and whole as when they started.**

**4. Relationships are precious; value and nurture them.**

***Let us never forget those fateful words, "Every time the search teams yelled there was only a deafening silence".***


*Thank you to Dr. Brett Hartis of Duke Energy for sharing this. May it be an important reminder to all of us how important our safety and the safety of others is.*

*Amy L. Giannotti, MS, CLM, (amy@aquastemconsulting.com) is the founder of AquaSTEM Consulting, LLC – an environmental consulting company specializing in lake and aquatic plant management, aquatic habitat restoration, and STEM communication and outreach initiatives. Amy is a Certified Lake Manager and has over 20 years of experience working in temperate and subtropical marine and freshwater systems.*

# FLOAT PLAN

INSTRUCTIONS: Complete this plan before you go boating and leave it with a reliable person who can be depended upon to notify the Coast Guard, or other rescue agency, should you not return or check-in as planned. If you have a change of plans, or will be delayed, notify the person holding your Float Plan. Finally, close your plan by notifying the holder you have arrived home safely and if the holder has reported you overdue, notify all applicable rescue authorities of your safe return.

www.cgaux.org

**Do NOT file this plan with the Coast Guard**

www.uscgboating.org

## VESSEL

**IDENTIFICATION:**

Name & Hailing Port _____

Document / Registration No._____ HIN _____

Year, Make & Model _____

Length _____ Type _____ Draft _____ Hull Mat._____

Hull & Trim Colors _____

Prominent Features _____

**COMMUNICATION:**

Radio Call Sign / Number _____

DSC MMSI No. _____

Radio-1: Type _____ Ch. / Freq. Monitored _____

Radio-2: Type _____ Ch. / Freq. Monitored _____

Cell / Satellite _____

Email _____

**PROPULSION:**

Primary-- Type _____ Eng.___ Fuel Capacity _____

Auxiliary--Type _____ Eng.___ Fuel Capacity _____

**NAVIGATION:** (Check all onboard)

☐ Compass ☐ Radar ☐ GPS / DGPS ☐ Depth Sounder

☐ Charts ☐ Maps ☐ _____

## SAFETY & SURVIVAL

**VISUAL DISTRESS SIGNALS:**

☐ Electric Distress Light (night only)

☐ Flag (day only)

☐ Flare, Aerial (day & night)

☐ Flare, Handheld (day & night)

☐ Signal Mirror (day only)

☐ Smoke (day only)

**AUDIBLE DISTRESS SIGNALS:**

☐ Bell

☐ Horn

☐ Whistle

**EPIRB:**

UIN* _____

**ADDITIONAL GEAR:**

☐ Anchor - Line length _____

☐ Dewatering device

☐ Exposure suits

☐ Fire Extinguisher

☐ Flashlight / Searchlight

☐ Raft / Dinghy

☐ Food for _____ days / person

☐ Water for _____ days / person

☐ _____

☐ _____

☐ _____

☐ _____

## PERSONS ONBOARD

**OPERATOR:**

Name _____

Address _____

City _____ State ____ Zip Code _____

Age ____ Gender ___ PFD ☐ PLB UIN* _____

Note _____

Has experience with: ☐ this vessel; ☐ the boating area(s).

Home Phone _____

Vehicle (Year, Make & Model) _____

Vehicle License No. _____ Trailer ☐

Vehicle parked at _____

Float Plan Note _____

**PASSENGERS / CREW:** (Identify all on board)

| | Name | Home Phone | Age | Gender | PFD | Note | Passenger PLB UIN* (Not listed in a specific order) |
|---|---|---|---|---|---|---|---|
| 1. | | | | | ☐ | | |
| 2. | | | | | ☐ | | |
| 3. | | | | | ☐ | | |
| 4. | | | | | ☐ | | |
| 5. | | | | | ☐ | | |
| 6. | | | | | ☐ | | |
| 7. | | | | | ☐ | | |
| 8. | | | | | ☐ | | |
| 9. | | | | | ☐ | | |
| 10. | | | | | ☐ | | |
| 11. | | | | | ☐ | | |
| 12. | | | | | ☐ | | |

If you have a genuine concern for the safety or welfare of the persons onboard this vessel that have not returned or checked-in, in a reasonable amount of time, then follow the step-by-step instructions on the Boating Emergency Guide™ located on the last page of this Float Plan.

(*) EPIRB and PLB registration required by Federal regulations. www.beaconregistration.noaa.gov

www.cgaux.org

# FLOAT PLAN continued

INSTRUCTIONS: Complete this plan before you go boating and leave it with a reliable person who can be depended upon to notify the Coast Guard, or other rescue agency, should you not return or check-in as planned. If you have a change of plans, or will be delayed, notify the person holding your Float Plan. Finally, close your plan by notifying the holder you have arrived home safely and if the holder has reported you overdue, notify all applicable rescue authorities of your safe return.

**Do NOT file this plan with the U.S. Coast Guard**

www.uscgboating.org

## CONTACTS

Contact 1 _____ Phone Number _____

Contact 2 _____ Phone Number _____

Rescue Authority _____ Phone Number _____

## ITINERARY

| | | DATE | TIME | LOCATION / WAYPOINT | MODE OF TRAVEL | REASON FOR STOP | CHECK-IN TIME |
|---|---|---|---|---|---|---|---|
| 1 | Depart | | | | | | |
| 2 | Arrive | | | | | | |
| | Depart | | | | | | |
| 3 | Arrive | | | | | | |
| | Depart | | | | | | |
| 4 | Arrive | | | | | | |
| | Depart | | | | | | |
| 5 | Arrive | | | | | | |
| | Depart | | | | | | |
| 6 | Arrive | | | | | | |
| | Depart | | | | | | |
| 7 | Arrive | | | | | | |
| | Depart | | | | | | |
| 8 | Arrive | | | | | | |
| | Depart | | | | | | |
| 9 | Arrive | | | | | | |
| | Depart | | | | | | |
| 10 | Arrive | | | | | | |
| | Depart | | | | | | |
| 11 | Arrive | | | | | | |
| | Depart | | | | | | |
| 12 | Arrive | | | | | | |
| | Depart | | | | | | |
| 13 | Arrive | | | | | | |
| | Depart | | | | | | |
| 14 | Arrive | | | | | | |
| | Depart | | | | | | |
| 15 | Arrive | | | | | | |
| | Depart | | | | | | |
| 16 | Arrive | | | | | | |
| | Depart | | | | | | |
| 17 | Arrive | | | | | | |
| | Depart | | | | | | |
| 18 | Arrive | | | | | | |
| | Depart | | | | | | |
| 19 | Arrive | | | | | | |
| | Depart | | | | | | |
| 20 | Arrive | | | | | | |
| | Depart | | | | | | |
| 21 | Arrive | | | | | | |

If you have a genuine concern for the safety or welfare of the persons onboard this vessel that have not returned or checked-in, in a reasonable amount of time, then follow the step-by-step instructions on the Boating Emergency Guide™ located on the last page of this Float Plan.

# USCG Float Plan - BOATING EMERGENCY GUIDE™

**BEFORE YOU BEGIN** – This guide is designed to work either with or without a Float Plan. You will need the following items: 1) the Float Plan, if one was given to you; 2) a pen or pencil; 3) a clean sheet of paper or writing tablet; and 4) your local telephone directory.

***Step 1:*** Do you have a genuine concern for the safety or welfare of any persons who have not returned or checked-in, in a reasonable amount of time?

If yes, then continue with **Step 2**. Otherwise **STOP** -- no further action is required at this time.

***Step 2:*** Were you given a prepared Float Plan by anyone on board the vessel?

If yes, then continue with **Step 3**. Otherwise, go to **Step 5**.

***Step 3:*** Locate the Contacts at the top of page 2 on the Float Plan. Call Contact number 1…

| IF CONTACT #1 | THEN |
|---|---|
| Answers phone | Take notes during your conversation.<br>1. Let the person know you are responding to a late return or check-in by the individuals designated on the Float Plan.<br>2. Determine if the person you are talking to, or anyone else at that location, has recently had contact with anyone on the vessel, and when and where that contact occurred.<br>3. Are you still concerned about the safety or welfare of any persons on board the vessel? |
| Does not answer phone | Continue with **Step 4**. |

| IF | THEN |
|---|---|
| Yes | Continue with **Step 4**. |
| No | **STOP**. No further action is required. |

***Step 4:*** Call Contact number 2…

| IF CONTACT #2 | THEN |
|---|---|
| Answers phone | Take notes during your conversation.<br>1. Let the person know you are responding to a late return or check-in by the individuals designated on the Float Plan.<br>2. Determine if the person you are talking to, or anyone else at that location, has recently had contact with anyone on the vessel, and when and where that contact occurred.<br>3. Are you still concerned about the safety or welfare of any persons on board the vessel? |
| Does not answer phone | Continue with **Step 6**. |

| IF | THEN |
|---|---|
| Yes | Continue with **Step 6**. |
| No | **STOP**. No further action is required. |

***Step 5:*** Using the checklist below, jot down only what you know about each item:

DO NOT SPECULATE. Incorrect information may mislead Search and Rescue personnel; add to the overall search and rescue time; and adversely affect the outcome.

- ☐ Period of time the vessel has been overdue.
- ☐ Purpose of the trip or voyage.
- ☐ Description of vessel. (Type, size, color, features, etc.)
- ☐ Vessel's departure point and destination.
- ☐ Places the vessel planned to stop during transit.
- ☐ Navigation equipment aboard. (Examples: GPS, radar, compass, sounder, etc.)
- ☐ Number of persons aboard. Relevant characteristics such as dependability, reliability, etc.
- ☐ Was the vessel initially docked or moored or did a vehicle tow it to a launch point?
- ☐ License plate number and description of the tow vehicle p and/or the passenger's transport vehicle.
- ☐ Communications equipment aboard, including type of radio and frequencies monitored, cellular or satellite telephone numbers of individuals, etc.
- ☐ Additional points of contact along the vessel's planned route.
- ☐ Operator and/or a passenger/crew member absolutely had to be back at the scheduled return time.
- ☐ Call your local Rescue Authority that responds to marine emergencies (Police. Sheriff, Constable, First responder, etc.).

Go to **Step 6–2**.

***Step 6:***

1. Call the Rescue Authority contact at the top of page 2 on the Float Plan.
2. Tell the dispatcher you are responding to a late return or check-in by the persons on board the vessel.
3. The dispatcher will instruct you from there.

> **Note:** The dispatcher will provide you with the necessary contact or agency connection to get a search and rescue mission started. This puts you in direct contact with the agency conducting the actual search and rescue, eliminating unnecessary middlemen.
>
> The dispatcher will tell you if he/she desires a follow-up call on the outcome of the rescue.

4. Continue with **Step 7**.

***Step 7:*** Be patient… you've done everything you can possibly do for now. It is important to keep the telephone available so emergency personnel can contact you with additional information and/or questions concerning the search and rescue effort.

**STOP -- End of Guide**

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# THE SCIENCE OF INVASION

With no native pathogens, grazers, or predators to control its spread, Hydrilla (*Hydrilla verticillata*) rapidly establishes a monotypic stand in many waterbodies as it outcompetes native vegetation for space, light, nutrients, and habitat.

We hear a lot today about the damaging effects of invasive species. Fortunately, there is an entire branch of science that studies the impacts of invasive species, the biological and financial costs associated with damage and management, and ways to improve our efforts. Yep! It is all part of something called invasion ecology.

What is invasion ecology? Invasion ecology is the science behind how invasive species impact the ecosystem as a whole. It includes the ways in which disruption to a native habitat occurs, and it involves how existing plants, animals, and the environment respond to the nonnative invader.

Today, invasion ecology is studied the world over as invasive species now impact every part of the earth – from the equator to both poles and from mountaintops to deep waterbodies. Invasive species problems are exacerbated by global trade, human activity, and climate change. If conditions are right, invasive species are capable of colonizing new areas, establishing in disturbed locations, tolerating pollution, and occupying the same habitat with existing natives. Some are even able to carve out an entirely new niche for themselves in their new territory. In fact, some countries and regions that are highly susceptible dedicate parts of their national security teams to 'biosecurity' to prevent invasion and establishment.

In general, there are **four stages** that occur in the process by which an invasive species colonizes a new region. Knowing these stages is helpful since the management approach to be implemented and the financial investment in management efforts partly depends on in which stage of invasion the new species is detected.

The first stage is *arrival* — this is where the species has successfully traveled or expanded outside of its native range. It may have done so via human activity or may have occurred due to natural events, like storms, flooding, winds, or transport via wildlife. If caught in this stage, managers must identify the method of introduction, examine the potential pathways of travel, and quickly assess the risk of whether or not this is likely to happen again.

Florida is particularly vulnerable to invasive species arriving in our state. Weather patterns and storm events introduce plant fragments and seeds via flooding and winds. Florida also has a lot of transportation hubs sprinkled around the state that serve as ports of entry for ships, cargo, passengers, and airline traffic. And until recently, there have been very few regulations on the transportation, distribution, and sale of invasive species. Even today, it is difficult to regulate trade of these species on the internet and enforcement initiatives can be challenging.

The second stage is *establishment*. If identified and addressed early in the establishment phase, eradication *may* be

possible. But more often than not, when an invasive species establishes, the population has grown in the new area such that extinction is unlikely. It is capable of successfully reproducing and its offspring are surviving. During the establishment stage, it is critical that managers understand the methods of reproduction at work. For instance, is it producing daughter plants, reproducing by fragmentation, producing seeds, tubers, turions, etc.? In many cases, there is more than one reproductive strategy at work. Multiple reproductive strategies allow invaders to reproduce rapidly and disperse far and wide from their original location of introduction. Invasive plants can also prevent the germination and/or stunt the growth of other plants, thus altering an entire ecosystem and potentially the entire food chain.

*Spread* is the third stage and occurs when the invasive species outgrows its original invasion site and infests a new location. The invasive species has had time to relocate, reproduce, has survived biological or environmental pressures (if any), and is now on the move. Careful and continuous monitoring, mapping, and modeling are necessary at this point to evaluate the potential threats to other ecosystems and native species.

Survey and monitoring are the foundations of an effective aquatic plant management program and help to document the spread of the invader. As a manager, it is critical to figure out what plants are present, which species need to be targeted in the new area, how much of the area is infested, and which species may be at risk from non-target damage. This is why it is important to map locations and document observations. What are you noticing about weather, water quality, wildlife present, currents, depth, clarity, land use around the lake/pond, and where in the waterbody the invasive plants are located? Be advised that water quality data may be an important factor in identifying how far and wide an invasive plant will spread and may offer options or limitations for treatment strategies. It is a good idea to know how to measure pH, dissolved oxygen, conductivity, etc., and what those parameters mean for the survivability of the invader, the habitat you are treating, and the tools/products in the management toolbox.

And lastly – *impact* …once this happens, impacts to local or regional ecology, biology, hydrology, economy, navigation, recreation, etc. are evident and require significant investment and intervention. If the invasive species has established and distribution is widespread, a management approach must take into account strategies to address long-term implications to the food web, local ecology, economy, etc.

So, how do we know or determine what is native and what is non-native, or why is this sometimes a controversial topic? Some people debate the nativity (or native region) of certain species. An example of this is water lettuce…. whose nativity in North America is debated by some.

There are several methods scientists use to examine when a species was first documented in a new location. The fossil record allows us to view a snapshot of what plants, animals, seeds, pollen, etc. were present in ancient times.

Early botanical records from naturalists and explorers are also relevant. Water lettuce was documented in Florida by the early explorer William Bartram in 1765 in his journals.

Scientists can also examine the detailed genetic information to see how closely related plants of the same (or different) species are that are living in proximity to the plant in question.

Scientists also look at evolutionary partners. This involves conducting detailed surveys to see what pathogens, grazers, and/or predators are also living in the native area and are responsible for keeping those plants in check. In the native range, there should be plenty of diseases, grazers, and/or predators that keep the organism in question from establishing in monoculture; but in the invaded area, these control mechanisms may be absent enabling huge areas to be infested by a single species.

Close examination of growth habits and patterns also provide an in-depth look. What is the mechanism of reproduction and how successful is it? Is the invader growing in with many other native species, or is it dominating the habitat or ecosystem? Native species have all kinds of "built-in" population controls, which is why we rarely see native species establish in monoculture, but rather

Water lettuce (*Pistia stratiotes*) encroaching on Spring Garden Run, DeLeon Springs State Park, Florida.

existing among a diverse collection of other native species and serving as a functional part of the food chain.

So, using water lettuce as our example here, scientific evidence points to it being native to South America (and possibly Africa) and was perhaps accidentally introduced into Florida sometime before the 1760s. Although it has been in Florida for a long time, it does not have natural predators or pathogens that keep its populations in check, its growth pattern is not typical of a native species, and its genetic history suggests it did not evolve in Florida as a natural part of freshwater ecosystems.

## So…what can we do?

The most economic and ecologically effective method is prevention. This involves placing a huge emphasis on public education and involvement up front to identify risky species early on. It also means advocating in support of laws and regulations that limit import and trade of potentially harmful invaders. Although the financial investment is significantly less at this stage, it may be difficult to garner support for the endeavor since the public has not yet felt the impact of the invader and may not even realize it is present. Therefore, prevention is often unrealistic, and species aren't targeted until their presence is perceived as problematic. If caught early enough, eradication is possible, but it involves more time and money than prevention.

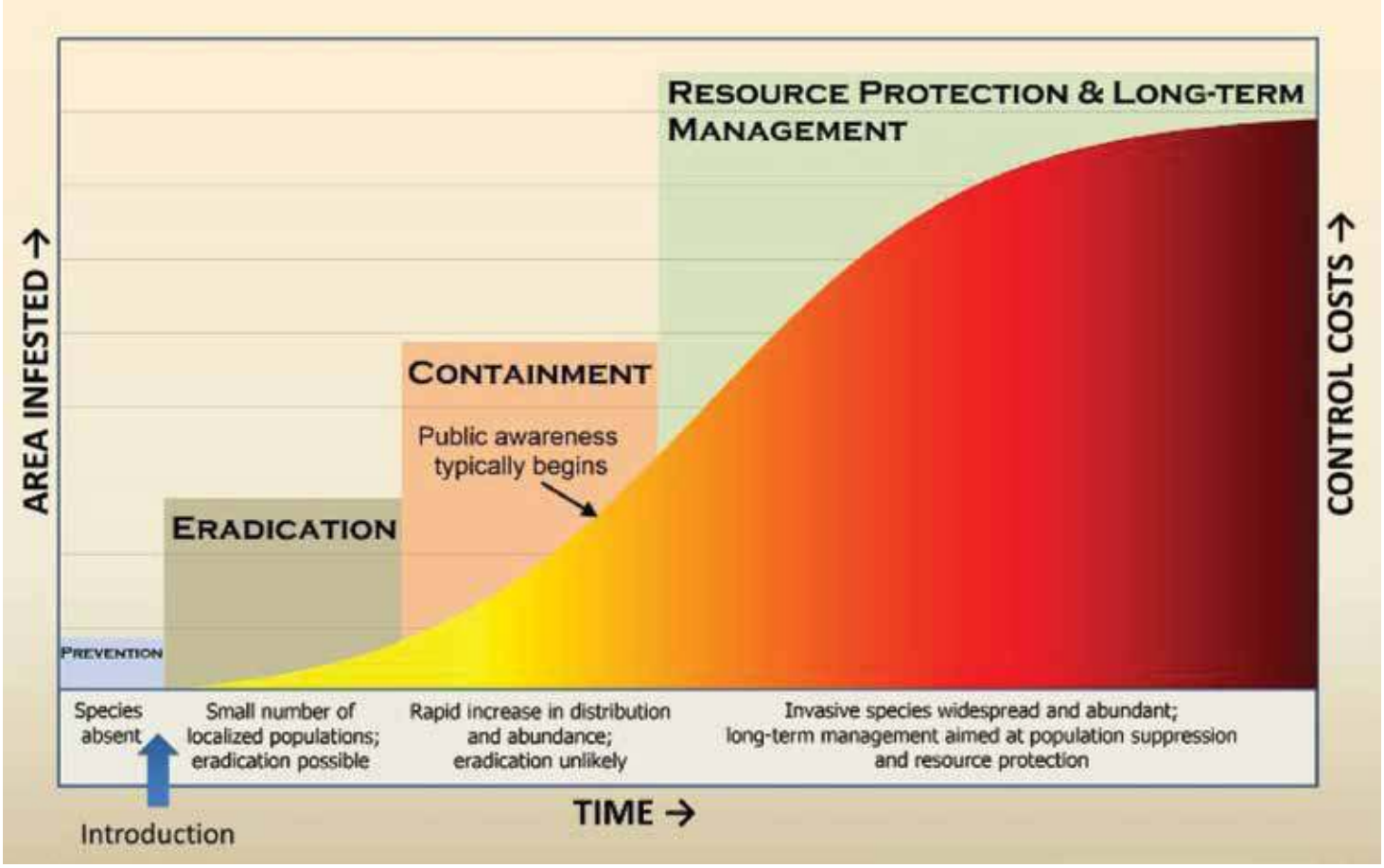
Once the invader has established and spread, eradication is less likely, and efforts focus on ways to contain the organism. This is costly, laborious, and this is usually the time the public "notices" as they take an interest in ongoing management efforts – maybe out of curiosity, or because it is inconveniencing them, or perhaps they are having to support management efforts financially, or because they perceive the strategies to not be necessary or even 'dangerous.'

When an invader has established and spread well beyond an area of containment, the only option is to invest fully in protecting the existing biodiversity from damage. This is expensive and requires a long-term commitment – both for program support and in financial investment.

This is why it is important to be vigilant in the field and know what you are planting on your shoreline, in your landscape, or growing in your aquarium. Once an invasive species escapes a controlled environment or containment structure, the resources needed to restore the habitat or control the spread can be significant.

## Helpful Ways to Reduce the Chance of Invaders Establishing:

1. Verify that plants you are buying for aquascaping on a shoreline or land-




This is the classic invasion curve that illustrates how eradication becomes very costly and highly unlikely the longer an invasive species is allowed to establish and persist in a new environment. Adapted from Invasive Plants and Animals Policy Framework, State of Victoria, Department of Primary Industries. 2010, and from "The Invasion Curve: A Tool for Understanding Species Management in South Florida", UFIFAS Publication #WEC347

scaping in a yard are not invasive. Use reputable extension sites on the internet to verify species, native ranges, and growth habits. Avoid doing a general search on the web as plant growers and distributors often use many common names and may even misidentify plant species.

2. Don't release aquarium fish, live bait, exotic pets, or aquatic plants into the wild. If you need to relinquish an exotic pet, contact your local wildlife agency for assistance (1-888-IVE-GOT1). Exotic plants can be placed in a ziploc bag, sealed, and disposed of in the garbage.

3. Be careful not to pack and transport a pest. CLEAN DRAIN DRY boat, seaplane, trailer, livewell, dive gear, waders, etc. before leaving the launch site and heading to a new waterbody. (stopaquatichitchhikers.org, dontpackapest.com, etc.)

4. Use native bait when fishing, and never dump the bait bucket in the water when finished.

5. Check your pet's paws and fur when hiking and swimming. Plant fragments and seeds can hitchhike to new location by hiding on your pet.

6. Learn about and be aware of invasive species in your area. Get involved with your local CISMA, engage with a local extension office and the classes they offer, and don't be afraid to contact a scientist directly.

7. If you see something, say something. There are many mobile apps and websites available now to report sightings and locations of invasive species. These data are critical for managers and scientists who are studying distribution and abundance. Report to EDDMapS.org, IveGot1.org, exotic species hotlines, etc.

**Every little bit helps, and together, we can make a difference!**

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# Picayune Strand Restoration Project

The Picayune Strand State Forest is located in southwest Florida in Collier County just east of Naples between Alligator Alley (Interstate 75) and the Tamiami Trail (U.S. 41). This mosaic forest consisting of cypress swamps, pine flatwoods, and wet prairies has a rich history and is now part of one of the largest restoration projects in the United States. The South Florida Water Management District (SFWMD) and U.S. Army Corps of Engineers (USACE) are working together to restore natural sheet flow to this section of the Everglades. This project is known as the Picayune Strand Restoration Project (PSRP) and was the first project to begin construction for the Comprehensive Everglades Restoration Plan (CERP). The project area includes 55,000 acres of Florida wetlands and uplands.

In the 1940's and 1950's this portion of the Everglades was divided, drained, logged and sold to developers. In the 1960's this area was further drained when 3 large canals (Miller Canal, Faka-Union Canal and Merritt Canal) were constructed. In addition, a road system was installed in anticipation of extensive residential development that is formerly known as the Southern Golden Gate Estates. The goal was to convert the forest into one of the world's largest subdivisions. Although canals were installed for drainage, heavy summer rain events still inundated much of the land and therefore further development did not occur. The drainage, logging and development dramatically degraded the ecosystem and altered native plant and animal communities, transforming the natural landscape, turning a healthy wetland ecosystem into a distressed and altered environment. Due to the disturbance created by drainage, logging and road construction, a perfect environment for invaders was created and enabled invasive plant and animal species to quickly recruit, establish, and outcompete native species within the project boundary.

## Restoration of PSRP

PSRP is a project component included in the CERP which was authorized by Con-

gress in 2000 as a plan to "restore, preserve, and protect the south Florida ecosystem while providing for other water-related needs of the region, including water supply and flood protection". The Assistant Secretary of the Army for Civil Works signed the Record of Decision, and Congress authorized the PSRP in the 2007 Water Resources Development Act (WRDA). In 2009, Congressional appropriations provided the USACE with funding to begin the restoration project. The first construction contract was awarded in October 2009.

Restoration for the PSRP involves backfilling 48 miles of canals, removing 260 miles of roads, removing logging trams and constructing three pump stations, all of which will restore more than 55,000 acres. In addition, levees will be constructed to protect adjacent private properties impacted by the project. Once restoration is complete, sheetflow will be restored across 85 square miles of land in western Collier County. PSRP's location is an essential part of the hydrologic flow, or sheetflow, of the Big Cypress Basin. Once the work is complete, wetlands will be restored in PSRP as well as in adjacent public lands including the Fakahatchee Strand State Preserve, the Florida Panther National Wildlife Refuge, and Collier Seminole State Park. This will reduce over-drainage and restore a more natural sheetflow of water to the Ten Thousand Islands National Wildlife Refuge. In addition, the project will restore historic water flows that benefit coastal estuaries and reduce large salinity fluctuations due to freshwater flowing from the Faka-Union Canal into the estuaries, recharge the aquifer, and protect the water supply while maintaining current levels of flood protection.

Construction is currently ongoing in the PSRP. To date, the three pump stations (Miller, Faka-Union, and Merritt) have been constructed, 75% of the roads and 93% of the logging trams have been degraded, and 55% of the canals have been backfilled. The work that remains to be completed includes degrading the remaining roads and trams in 2022, constructing the southwest protection features (levees) in 2023, and backfilling the Faka-Union (9 miles) and Miller (8 miles) Canals in 2024.

Ecological benefits are already being observed at PSRP as a result of the restoration completed to date. Native plants and animals are returning to the area that have been absent for decades, including the wood stork and the endangered Florida panther. By restoring the hydrology in the area, the project also directly benefits the southern Gulf Coast estuaries, improving juvenile fish habitats and increasing fish and bird populations, as well as providing recreational opportunities in the area.

Although ecological benefits have been realized within the project boundary, both invasive plant and animal species persist within the general area. Dominant species of plants within the project include Brazilian pepper and cogongrass, melaleuca, Old World climbing fern, earleaf acacia and torpedograss. Brazilian pepper is the most dominant invasive plant and occupies approximately 14,000 acres or 25% of the restoration footprint. In addition, the Burmese python is also a significant threat to the recovery of the PSRP as a whole.

## PSRP & Invasive Species Management

Each new USACE project requires a *Project Implementation Report* (PIR) in order to be approved and authorized for construction. The PIR is a document that provides information on plan formulation and evaluation, engineering and design, estimated benefits and costs, environmental effects, and additional information and analysis necessary for the Secretary of the Army or Congress to approve and authorize the project for implementation. Prior to 2012, there was no guidance for the completion of PIR's concerning invasive species. In several cases, invasive species were not addressed in the PIR's and therefore funding for management of invasive species was not included in these prior project authorizations. With smaller CERP projects, invasive species management costs are not as significant and can be completed during the construction phase of the project without major impacts to the overall cost of the project. The PIR for PSRP was completed prior to the establishment of guidance for including invasive species management and therefore funding was not specifically identified for management of invasive species. Since the project is so large and the invasive species infestations are extensive, management for invasive species is limited to project construction footprint.

In 2009, a Vegetation Management Plan was completed for PSRP that outlined the priorities for managing vegetation. The USACE Jacksonville District Invasive Species Management Branch in coordination with the SFWMD have been conducting invasive plant treatments within the construction footprint of the project since 2009. The majority of terrestrial plant species that have been treated include Brazilian pepper and cogongrass. During the construction phase of the project, the USACE is responsible for managing invasive plant species within the construction footprint. Since management is only conducted within the construction footprint, the majority of invasive species are not treated during this phase (construction) of the project. Following project turnover and during the Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) phase, the SFWMD is responsible for completing invasive species management within the 55,000-acre restoration project. The two main objectives for vegetation management include facilitating desired native vegetation within the construction footprint and to remove invasive and nuisance species in forested areas outside of the construction footprint. In addition, the SFWMD also conducts monitoring and removal of the Burmese python.

## Vegetation Removal along Canals

As part of the restoration effort, the ISMB assists in-house crews by removing vegetation along the canal banks prior to backfilling the canals. This work is completed via the Vegetation Management (Florida and South Atlantic Division) contract. In 2016, vegetation was removed along a one-mile portion of the Stair Step Canal. In the winter of 2020/spring of 2021, vegetation was removed along a three-mile portion of the Faka-Union

Canal. The primary invasive vegetation that was removed here was Brazilian pepper.

In order to complete the removal of vegetation, various environmental compliance measures must be implemented. Personnel working on the site are educated about the various endangered species present and what to do if one is encountered or injured during the performance of work. In addition, a Wildlife Biologist and Archeologist must be on site to monitor work performance and document any observations of endangered species or to document/protect any site artifacts. In addition, personnel are required to report sightings of Burmese pythons.

No endangered species were harmed during the work for either project; however, contract personnel did report a capture of a Burmese python. In January 2021, Ian Markovich and Jessica (Skippy) Fair were on site a PSRP at the Faka-Union Canal performing a site visit for the ongoing vegetation removal work. During the site visit, they received a call from the Contract Safety Officer that a Burmese python had been seen in the area where the contractor was working. The Florida Forest Service and U.S. Fish and Wildlife Services were notified about the Burmese python, and they were authorized to capture the snake. Once Ian and Skippy arrived at the site, Skippy was able to use the training she received from the Florida Fish and Wildlife Conservation Commission to successfully and safely capture and properly euthanize the Burmese python. It was first transported to Florida Forest Service office and was subsequently relocated to a research facility to help scientists study the snake's diet, growth, fecundity and movement. The captured Burmese python was a 10-foot male, and these snakes can grow to be twice that long. The largest snake captured in Florida was found in October 2020 at the L-28 Tieback Canal near Miami and was 18.9 feet, which barely surpassed the previous record of 18.8 feet captured in Big Cypress in 2013.

These large-bodied animals are wreaking havoc on our natural species. They consume whitetail deer, alligators, small to medium-sized mammals, and a variety of wading bird species. Currently, python hunters are permitted to hunt and kill pythons across the Everglades including in PSRP. However, their 1% detection rate makes these cryptic species extremely difficult to find. Research and management of this species is important not only for the restoration of Picayune Strand State Forest, but for the entire Everglades system. EDD Maps shows population expansion happening rapidly and these pythons are

expected to establish well beyond the South Florida region soon if populations are not controlled and expansion is prevented.

*Angie Huebner is a Biologist with the US Army Corps of Engineers South Atlantic Division. She has been involved in invasive species management for the USACE, Jacksonville District that includes Comprehensive Everglades Restoration Projects, the Kissimmee River Restoration Project, Modified Water Delivers, Central & South Florid Flood Control Project and Lake Okeechobee and the Okeechobee Waterway. In addition, she has assisted with execution of invasive species management projects for the USDA Natural Resource Conservation Service, the United States Navy & Marine Corps.*

*Jessica "Skippy" Fair has also been involved in invasive species management for the USACE, Jacksonville District that includes Comprehensive Everglades Restoration Project specifically Picayune Stand, Kissimmee River Restoration Project, Natural Resource Conservation Service, WRP lands and Lake Okeechobee and the Okeechobee Waterway.*

# Principles in SAV Community Ecology that Support Aquatic Plant Management

**Thayer[1], J., J. Leary[1], K. Gladding[1], A. Riner, J. Glueckert[1], C. Boever[2] and A. Dew[2]**

The littoral zone is defined as the near shore area of a water body where 1% of ambient light reaches the sediment bottom (i.e., euphotic zone), supporting aquatic macrophytes. Many lakes in Florida are shallow with proportionally large littoral zones sustaining an abundance of rooted submersed aquatic vegetation (SAV). Large SAV communities are strong influencers on lake limnology controlling water chemistry, flow dynamics, habitat and sedimentation among many other qualities of these dynamic ecosystems. There are twenty-one species of SAV known to be naturalized in Florida, of which, four are exotic and invasive (see table; Hoyer 1996). Many of the common native SAV coexist in diverse community structures, sharing the littoral space and include: eelgrass (*Vallisneria americana*), coontail (*Ceratophyllum demersum*), southern naiad (*Najas guadalupensis*), pondweeds (*Potamogeton* spp.), bladderworts (*Utricularia* spp.) and the macroalgae nitella (*Nitella* spp.) and musk grass (*Chara* spp.). However, the most dominant SAV in Florida is the invasive hydrilla (*Hydrilla verticillata*). Since its arrival, over 70 years ago, this species has repeatedly demonstrated a capacity to establish large, monospecific infestations exclusive of other SAV and becomes so extensive it can change the function and usability of an entire lake. Here, we introduce concepts in community ecology to describe the interactions between invasive hydrilla and native SAV and how selective management can preserve and promote mixed native SAV communities.

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[2] Invasive Plant Management Section, Florida Fish & Wildlife Conservation Commission

Community ecology seeks to define the complex biotic interactions of multiple species coexisting within a defined ecosystem. These interactions may be mutual (i.e., both species benefit), commensal (i.e., one benefits with affecting the other), competitive (i.e., both species suffer) or predatory/parasitic (i.e., one benefits with direct suffering of the other). Invasive plant species are, by definition, competitive ecological disruptors. According to Hardin (1960), the competitive exclusion principle (also known as Gause's Law) reasons that a superior species with the slightest competitive advantage will establish hierarchy and eventual exclusion over inferior community members within a shared niche space, fait accompli. This proposition resonates clearly with those who subscribe to early detection and maintenance control of invasive species.

All SAV community members, must compete for light, carbon, nutrients, and space for survival. Littoral zones, while suitable for SAV growth, are often limiting in these resources over space (e.g., bathymetry) and time (e.g., season). A fundamental niche is defined as the full complementation of environmental conditions suitable for a single species to thrive without biotic interference. However, inferior, co-existing species are most likely constrained to a realized niche that may be less suitable but still offers the slightest competitive advantage over other community members. The ability of an inferior species to "carve out" a new niche may be the difference between survival and

**Glossary of Ecological Terminology**

| | |
|---|---|
| Community Ecology | Study of interacting species within a defined ecosystem |
| Community Structure | Species presence, abundance, and interactions within a defined ecosystem |
| Fundamental Niche | Total ecological space supporting species occupation without competition |
| Realized Niche | Utilized ecological space constrained by interspecific competition, i.e., less than the fundamental niche |
| Limiting Resource | Biotic or abiotic factors in low availability restricting species growth and fitness |
| Coexistence | Multiple species inhabiting the same ecosystem with different niches |
| Competitive Exclusion | Extinction of inferior competitors within a shared niche |
| Environmental Filters | Abiotic gradients that define niches, e.g., light, temperature, nutrients, etc. |
| Ecological Succession | Change in community structure over time |
| Ecological Fitness | The capacity to survive and thrive in an ecosystem |
| Biodiversity | Variety of life in a defined ecosystem |
| Evenness | Relative species abundances represented within a community |

## Diversity of SAV in Florida Lakes

| Scientific Name | Common Name | Native/Exotic |
|---|---|---|
| *Bacopa caroliniana* | lemon bacopa | Native |
| *Cabomba caroliniana* | fanwort | Native |
| *Ceratophyllum demersum* | coontail | Native |
| *Chara spp.* | muskgrass | Native |
| *Egeria densa* | Brazilian elodea | ***Exotic*** |
| *Eleocharis baldwinii* | road grass | Native |
| *Fontinalis spp.* | water-moss | Native |
| *Hydrilla verticillata* | hydrilla | ***Exotic*** |
| *Mayaca fluviatilis* | bog moss | Native |
| *Micranthemum umbrosum* | baby's-tears | Native |
| *Myriophyllum spicatum* | Eurasian water milfoil | ***Exotic*** |
| *Najas guadalupensis* | southern naiad | Native |
| *Nitella spp.* | stonewort | Native |
| *Potamogeton diversifolius* | variable-leaf pondweed | Native |
| *Potemogeton illinoisensis* | Illinois pondweed | Native |
| *Potemogeton pectinatus* | sago pondweed | Native |
| *Rotala rotundifolia* | roundleaf toothcup | ***Exotic*** |
| *Sagittaria kurziana* | strap-leaf sagittaria | Native |
| *Utricularia spp.* | bladderwort | Native |
| *Vallisneria americana* | eelgrass | Native |
| *Websteria confervoides* | spider-grass | Native |

Hoyer, M. V. (1996). *Florida freshwater plants: a handbook of common aquatic plants in Florida lakes*. University of Florida, Institute of Food & Agricultural Sciences.

extinction (Bøhn *et al.* 2008). In theory, successional native communities increase in complexity as each species identifies its own niche. Meanwhile, an invasive species may have a multitude of competitive advantages that portrays broader environmental adaptability conducive to occupying larger spaces approaching its fundamental niche and inherently overlapping with the niche spaces of inferior community members.

Environmental heterogeneity increases lake-level species richness suggesting that native and invasive species can co-exist with a variety of realized niche spaces. There has been much research (and debate) on the biotic resistance of diverse communities from species invasions, (i.e., the diversity-invasibility hypothesis; see Elton 1958). However, recent scientific evidence on SAV communities in Minnesota lakes suggested that biotic resistance was not expressed by diverse communities (Muthukrishnan *et al.* 2019). Instead, the authors observed that the invasive SAV was less sensitive to environmental gradients (e.g., Secchi disk) and further expressed competitive exclusion in overlapping niche spaces reducing local diversity in the littoral zone.

Light, as described above, is an important environmental condition of the littoral ecosystem and is inversely correlated to water depth. Typically, SAV communities occupy deeper sections of the littoral zone with less competition from emergent species, albeit in lower overall light conditions. Research has demonstrated hydrilla to exhibit a lower light compensation point (Van *et al.* 1976), which effectively translates into hydrilla able to start photosynthesizing earlier in the day and in deeper water via the slightest physiological advantage measured in micro-scale. In the figure above we can observe from point-intercept data how eelgrass, Illinois pondweed and hydrilla are occupying different niche spaces on Lake Sampson. It is quite fascinating how congruent these realized niches are with the bathymetry, suggesting a strong environmental gradient filtering niche selection. While eelgrass and pondweed appear to coexist in shallower depths, we see hydrilla exclusive in deeper water and further overlapping with the "diverse" native niche space. We presume this phenomenon in community ecology to be light-dependent but could be induced by a multitude of other factors as well (Koch 2001). In this case and several other Florida lakes we ask similar questions posed by Muthukrishnan *et al.* (2019):

***Is a diverse native SAV community biotically resistant to hydrilla invasion?***

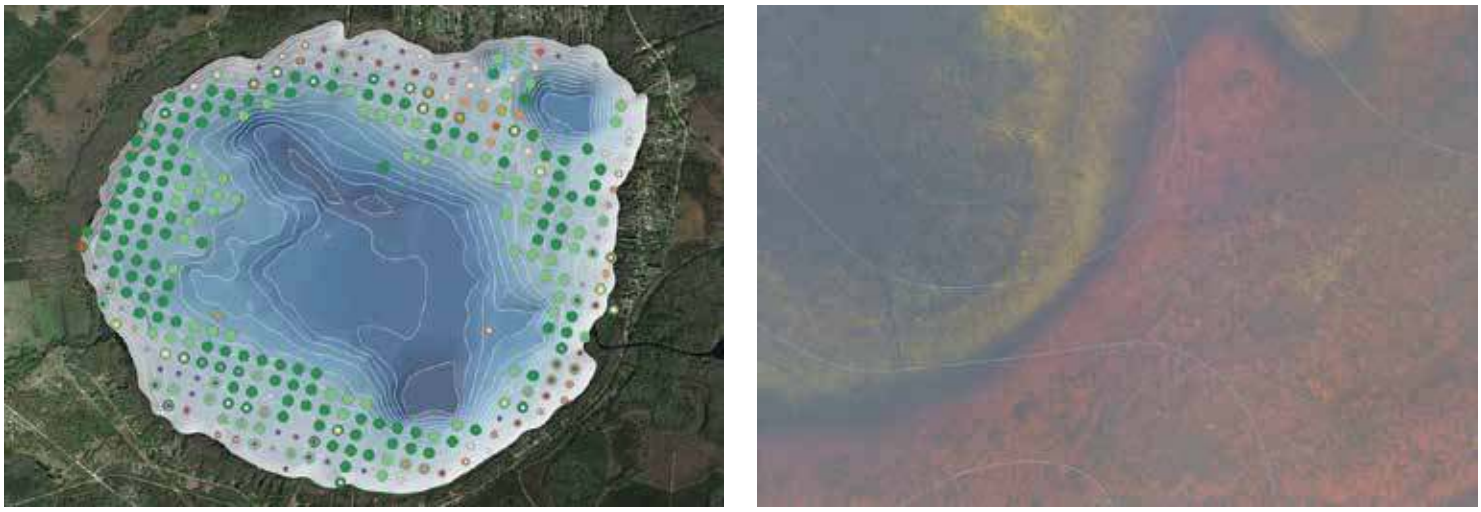
or

***Is coexistence of hydrilla in a native SAV community an early onset of competitive exclusion?***

or

***Does exclusive occupation of a deep-water niche by hydrilla have any negative ecological consequences?***

Unfortunately, this article is not prepared to offer conclusions to these big picture questions. However, if we consider the rich history and professional experience applied to managing hydrilla in Florida, we can appreciate the uncertainty and risk involved by assuming hydrilla is sympatico with the other members of a diverse SAV community. So, how do we manage for desirable SAV communities? First, we need to continue with understanding realized and fundamental niche spaces of native communities impacted by hydrilla. Is deeper water only unrealized to native species due to competitive exclusion and could they succeed without competition despite lower fitness? If the fundamental niche for the native community is confined to the shallow depths, it would stand to reason that management be confined to selective interventions on invaded, mixed communities? On the other hand, foreknowledge of



SAV community structure of Lake Sampson, Bradford County. Point-intercept survey of SAV conducted by the FWC Fish and Wildlife Research Institute in September 2020 (left panel); Note eelgrass (purple) and Illinois pondweed (orange) occupying the shallow contours, while hydrilla is exclusively occupying deeper water and overlapping with native SAV. A closer view with aerial imagery (3 cm pixel resolution) showing hydrilla (HVA) and native SAV (PIS/VAA) niches congruent with depth bathymetry.

hydrilla's lack of sensitivity to environmental filters would validate preemptive management to mitigate the spread of isolated, monospecific infestations.

A better understanding of SAV community ecology offers new ways for generating usable field intelligence in planning an evaluating all forms of aquatic plant management with a focus on selectivity and preservation of diverse, native plant communities. New computational methods in ecological niche modeling may greatly enhance hydrilla management strategies in conservation areas (Zhu *et al.* 2017). Here, the concept of selectivity expands from a familiarity of chemical selectivity in mixed communities to spatial selectivity targeting mono-specific hydrilla infestations with even a broad-spectrum herbicide.

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# A Simple Device Manages the Eco-scape

I stood watch as airboat propellers buzz and spin like a half-dozen whirligigs in the morning light, skipping through the 734 square miles that make up Lake Okeechobee….. all religiously searching for expanding mats of invasive aquatic plants.

Many of these whirling watercraft operators are piloting a new device that promises efficiency, efficacy, and most importantly accountability. U.S. Army Corps of Engineers, biologist Jessica Fair and Keith Mangus, project manager at Applied Aquatic Management, took me out on the lake to explain how this small, inconspicuous device will revolutionize the management of invasive plants.

The U.S. Congress has often left the management of invasive aquatic plants to government agencies and their contractors through its enacted "The Rivers and Harbors Act" of July 3, 1958, Public Law 85-500, Section 104. Since the 1800s, the U.S. Army Corps of Engineers (USACE) and their partners have taken on the daunting task of maintaining our Florida waterways (and minimizing) the impacts of invasive aquatic plant species. Invasive species cause economic losses of more than $138 billion in the U.S. annually.

Invasive aquatic plant species can clog up waterways, which may slow down or stop the transportation of recreational vehicles and commerce. Large mats of water hyacinth can take out a bridge or lock gate and outcompete native plants.

In order to stop the destruction of infrastructure, USACE and its partners are using three methods of management: biological, mechanical, and chemical. Each process varies in its effectiveness depending on the species of aquatic plant being treated – leaving the team to rely heavily on data to determine the best method in invasive aquatic plant reduction.

For years, our public has called for more transparency on the process and efficacy of invasive plant management. The urgent appeal has increased with the awareness of how precious our water resources are and the fragility of the ecosystems that depends on them.

Florida Fish and Wildlife (FWC), is an active partner in the management of invasive species.

Mangus said, "FWC took a pause from managing invasive plants to ask for feedback from the public. The response was: no one is overseeing the contractors, and they are out there spraying everything." This was just one of the many reasons agencies and contractors alike saw the opportunity and decided to revisit finding a solution to meet the publics' request.

FWC engaged its partners as they worked to find a way to provide more oversight.

It was biologist, Alex Dew from FWC that had the insight and ingenuity to modify and create a program that does more than just giving oversight.

Dew and his team had been looking at new technologies to implement, that were adaptable for the methods used by state and federal agencies to manage invasive plants.

Dew explains how he came up with the idea. "We finished a project where we were using some GPS units, and we noticed that there was a signal and there were inputs on the wire. I started testing things out, and I figured out that I could rig up a switch valve to the herbicide tank and then use that to pair it with the GPS".

Once FWC was able to install the system, they realized that they could also monitor, mechanical management systems. Dew noted that the GPS unit had already been developed just for a different purpose. "I just repurposed it and adapted it to use with our current technology."

With the device and the platform still in its early stages, FWC invited partners like USACE and local contractors to demonstrate the tool and invite them to be a part of the pilot program.

Fair said, "USACE wants to become more transparent in our spray programs. We want to work together to improve oversight and to be able to compile more accurate surveys of invasive aquatic plants; this program can do that and more."

In an airboat with Fair and Mangus, using the FWC's Spray Tracker platform on their cell phone they quickly located the contractors' licensed applicators piloting the device.

Upon reaching one of the applicators, he shows us an inconspicuous brass valve and a black box fixed to the back of the pilot's seat.

Mangus proceeds to explain the process. "The Spray Tracker is an internet-based platform. It is a simple GPS tracker unit that has inputs and a solenoid valve that opens and closes as the applicator is applying gun pressure. As this is happening, the platform records two separate tracks one track that shows the navigational path of the airboat in one color and a track that shows the spray path in another. That spray tract indicates where we have actually treated the invasive aquatic plants."

Mangus further explains that this is an essential tool for the industry. This GPS technology makes sure that the licensed applicators are working in the designated areas and are being efficient. The platform also shows parameters that need to be avoided, such as "snail kite nesting buffer zones" and water intakes.

Fair and Mangus then take off to another location on the Lake. When we arrive, there amongst the mats of water hyacinths were small remnants of fragrant white lilies that were trying to grab the last bit of sunlight before succumbing to the water hyacinths aggressive nature.

"Water Hyacinths are not native to our area. It outcompetes our native vegetation. A certain area that may have been filled with lilies or an ecologically diverse patch of native aquatic plants, will be taken over in weeks or even days by the water hyacinths. They ruin the habitats, promotes mosquito growth and impacts both dissolved oxygen and turbidity," says Fair.

They explain that the area we were floating on had recently been treated for invasive plants. Mangus and Fair can view the tracks from their device. Since the waterlily is rooted in the soil, the lilies there will quickly produce new flowers and pads after the water hyacinth dies out, taking this

area back from the invasives. The program helps them know the exact location in real-time that an applicator applies the designated herbicide.

"For a biologist going out surveying, sometimes, the effect of the herbicide takes days and even weeks for us to see," says Fair. "Before this technology, when biologists went out to survey, collect data, and verify that the applications were working, we had a general idea of the treated areas. But now, with this program, we can pull it right up on the platform and see if the area was treated. With that information we can compile our survey data and direct our contractors better. It helps us to be more effective, save time and money."

What started out as a Sirens call to find a better way of conserving our environment and holding state and federal agencies accountable for their invasive aquatic plant management was just a seed to find an innovative solution.

The solution is a program comprised of a device and a platform that meets the requirements of the unforgiving weather conditions on Lake Okeechobee, the whizzing and whirling of the airboats it needs to fit on, and an accurate, user-friendly platform.

Dew, Fair and Mangus, know that the all possibilities of this program have yet to be explored and further developed. Now the team has the data, and the imagery needed to be transparent to the public. The team can give them the requested information in real-time: the when, where and how they are chemically and mechanically managing invasive aquatic plants.

In keeping with the promise of efficiency, efficacy, and accountability USACE, FWC, their partner agencies and contractors alike can strive to maintain clear waterways, keep our infrastructure safe, and conserve our native ecosystems.

*Photos and Story by Brigida I. Sanchez. Reprinted with permission from the US Army Corps of Engineers.*

# Working Together to Protect Florida's Waters

In August 2021, the Florida Department of Agriculture and Consumer Services (FDACS) Office of Agricultural Water Policy (OAWP) announced a Clean Water Initiative to improve water resource protections statewide. Florida's waterways are not only battling invasive aquatic plants, but resource managers struggle to manage the suite of problems that results from nutrient pollution in stormwater runoff.

Florida is the 22nd largest state in land area, but the 3rd largest in surface water area[1]. Our fresh water ranks 8th nationally in drinkability[2]. It stands to reason that this abundant resource is a main driver for accommodating the 3rd highest resident and 2nd highest visitor populations in the country. Also, did you know, that 23% of Florida's land area (9.7 M acres) is dedicated to agricultural production, with our top-ten crops dominated by fresh market fruits and vegetables valued at over $2.4B[3] annually, supplying grocery stores with fresh produce across the country. Many of our farm production values are second only to California. The current, catastrophic drought in the western US should cue our readers to Florida having a critical role in national food and water security contingency plans and policies. With emphasis, the protection of our freshwater resources is vital to state economy and national security.

Under the mandates of the federal Clean Water Act, states are required to classify all surface waters under five different categories ranging from potable to navigable designated uses. Each category must meet minimum water quality standards that guide policies in pollution mitigation[4]. You may have heard the term Total Maximum Daily Load or TMDL for short, which is defined by the Environmental Protection Agency as "…the calculation of the maximum amount of a pollutant allowed to enter a waterbody so that the waterbody will meet and continue to meet water quality standards for that particular pollutant."[5]

Nutrients are vital to all plant growth and the use of synthetic fertilizers remains an important practice for beautifying urban and residential landscapes and enhancing agricultural productivity. However, too much of a good thing can be harmful. Excessive nutrients cause a decline in water quality, loss of biodiversity, decreased oxygen, and impacts to wildlife that live in the lakes, rivers, canals, estuaries, and oceans. To many people, the thought of "nutrients" being a problem is hard to comprehend. We often think of nutrients like "vitamins" and assume that they can't do much harm, but that is not the case.

In Florida the two most prominent pollutants are the nutrient forms of phosphorous and nitrogen. These nutrients enter our waters in a variety of ways and exist in many different forms. Nutrients are substances that are needed by all plants and animals for proper growth, and they

are also present in all types of waterbodies. However, too much of a good thing can be harmful as nutrients stimulate the growth of algae, cyanobacteria, and invasive plants.

While nutrients are naturally abundant in our aquatic systems, additional non-point source inputs from residential and agricultural activities can create an imbalance and environmentally degrade our natural aquatic systems. Today, the Florida Department of Environmental Protection (FDEP) lists over 1700 impaired water bodies out of compliance with water quality standards.

The abundance of freshwater systems in Florida are often in close proximity to these activities and inherently vulnerable to excess nutrient runoff, which can stimulate harmful algal blooms, toxic cyanobacteria, and aggressive plant invasions, and which further cascade to reduced habitat quality, increased human health risks and hazardous obstructions to navigation and access.

We are all, in some way, contributors to non-point source nutrient pollution. Nutrient pollution is common in urban systems that receive stormwater runoff, where lots of pavement is present, and where fertilizers are applied regularly in landscaping. And nutrient pollution also results from agricultural activities within a watershed.

The FDEP develops TMDLs for all waterbodies impaired by non-point source pollution and establishes basin management action plans (BMAPs) for watersheds feeding into these impaired water bodies. For its part, FDACS recently announced their Clean Water Initiative[6] to improve farmer programs promoting best management practices (BMPs) designed to reduce nutrient loads in compliance with the respective BMAP [4].

What are agricultural BMPs? According to Florida statute (Section 373.4595(2)(a), a BMP is defined as a means or practice, determined by experts, to be effective and practicable way to balance water quality improvements and agricultural productivity. The FDACS identifies three categories of agricultural BMPs, or Best Management Practices:

- Nutrient management optimizing nutrient inputs (including manure) with crop demand.
- Irrigation management to optimize moisture availability below field capacity.
- Non-point source pollution management to mitigate sediments and nutrient runoff

In a 2021 Report to the Governor[7], the FDACS Office of Agricultural Water Policy (OAWP) estimated 62% of the overall agricultural acreage to be enrolled in an approved BMP program. This balanced approach to profitability and environmental stewardship will enhance Florida's role as a key contributor to national food security. Mitigation of nutrient loading into our freshwater bodies will improve water quality and extend the values of aquatic plant management stewarding our precious aquatic resources.

The FDACS Office of Agricultural Water Policy is collaborating with agricultural producers, research universities, the water management districts, and the Florida Department of Environmental Protection to reduce impacts to water quality and promote practices that conserve water statewide. In 2019, Florida reported 47,400 farms and ranches occupying 9.7 million acres of land providing a variety of foods from citrus to vegetables to sugarcane and livestock. These BMPs are cost-effective solutions that agricultural producers can implement to address nutrient loading in waters from animal waste, fertilizers, pesticide applications, and other activities associated with their farming operations.

The Clean Water Initiative is actively addressing pollution prevention measures by:

- Updating Florida's Agricultural Best Management Practices with the latest research, data, and technologies available
- Prioritizing high-value projects within the Cost-Share program to get the greatest bang for the buck as our farmers continue to employ more efficient nutrient and water usage practices as stewards of the land

To learn more, visit: https://www.fdacs.gov/News-Events/Press-Releases/2021-Press-Releases/ICYMI-Commissioner-Nikki-Fried-Announces-FDACS-Clean-Water-Initiative

[1]www.usgs.gov/special-topic/water-science-school/science/how-wet-your-state-water-area-each-state?qt-science_center_objects=0#qt-science_center_objects

[2]www.usnews.com/news/best-states/rankings/natural-environment/air-water-quality

[3]www.fdacs.gov/Agriculture-Industry/Florida-Agriculture-Overview-and-Statistics

[4]floridadep.gov/dear/water-quality-standards/content/surface-water-quality-standards-classes-uses-criteria

[5]www.epa.gov/tmdl/overview-total-maximum-daily-loads-tmdls

[6]www.fdacs.gov/News-Events/Press-Releases/2021-Press-Releases/ICYMI-Commissioner-Nikki-Fried-Announces-FDACS-Clean-Water-Initiative

[7]www.fdacs.gov/ezs3download/download/98382/2665697/Media/Files/Agricultural-Water-Policy-Files/BMP-Implementation/2021-status-of-bmp-implementation-report.pdf

- Supporting multi-faceted practices such as cover crops and no till drills that provide significant climate mitigation and carbon sequestration benefits
- Conducting in-person site visits in cooperation with our agricultural stakeholders rather than relying on voluntary self-reporting when it comes to compliance
- Working with producers on corrective action plans and referring cases of non-compliance to the Florida Department of Environmental Protection for enforcement
- Collecting and aggregating detailed records of the nutrients being applied by agricultural producers on the production landscape
- Increasing transparency and coordination with the public, stakeholders, the agriculture industry, and our agency partners through enhanced education and training outreach, including in-person and online resources.

Stormwater runoff is highly regulated in municipalities via mandates in the Clean Water Act, National Pollutant Discharge Elimination System (NPDES), Basin Management Action Plans (BMAPs), etc., and it is hoped that this new initiative will help address nutrient loading from agricultural sources, too. Education outreach, engagement, and implementation of the strategies mentioned above will hopefully help reduce algal blooms, red tide, and impacts to wildlife, improving the health and biodiversity of Florida's waters.

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# 2021 Calendar of Events

***With the disruption of meetings due to COVID-19, please see links to upcoming meetings and conferences. Some of these may have virtual learning options available and some may change entirely since this issue of Aquatics went to print, so please check the websites for updated information. Updates and announcements are also made on the various social media channels, so monitor those for information, too.*

**October 6-8, 2021**
**South Carolina Aquatic Plant Management Society Annual Meeting**
Myrtle Beach, SC
http://scapms.org/meetings.html

**November 15-17, 2021**
**Texas Aquatic Plant Management Society**
Bryan, TX
https://www.tapms.org/2021-annual-meeting/

*Need CEUs but don't see anything that fits your schedule? Visit the FDACS website and search for available CEU classes here: http://aessearch.freshfromflorida.com/AvailableClassSearch.asp. For more information about licensing, certification and finding Florida CEUs, check out "CEUs just for you" in the Summer 2014 issue of Aquatics magazine (http://fapms.org/aquatics/issues/2014summer.pdf)*

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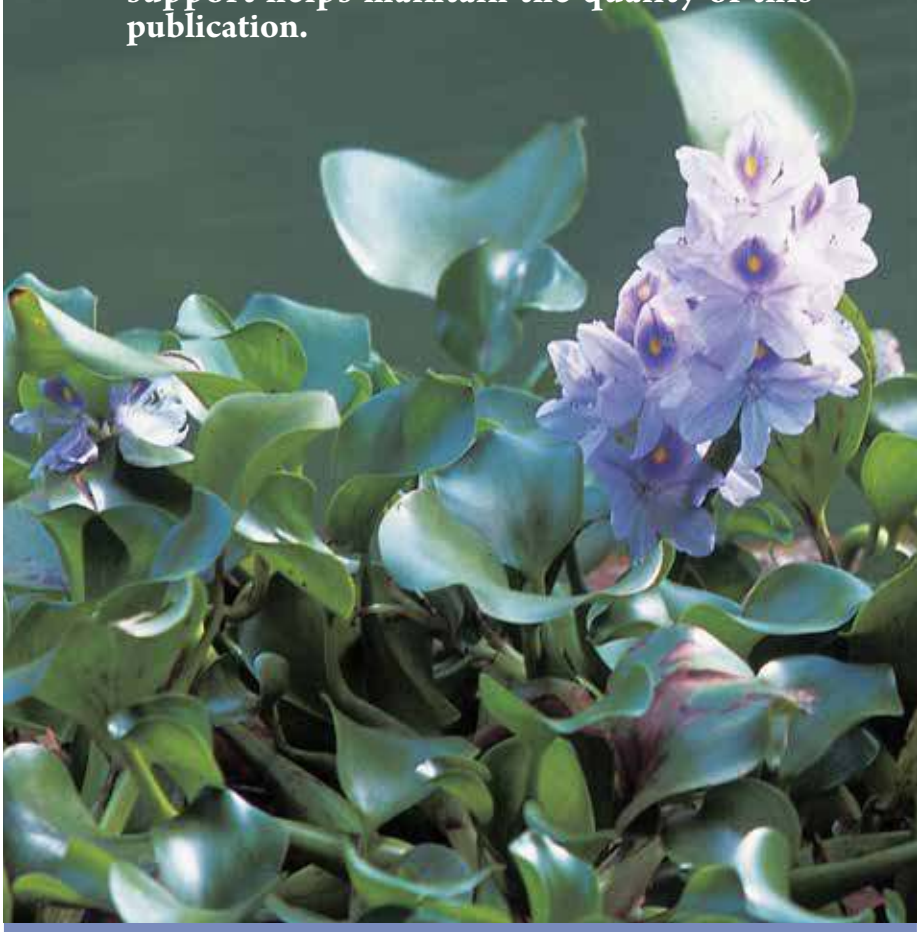

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