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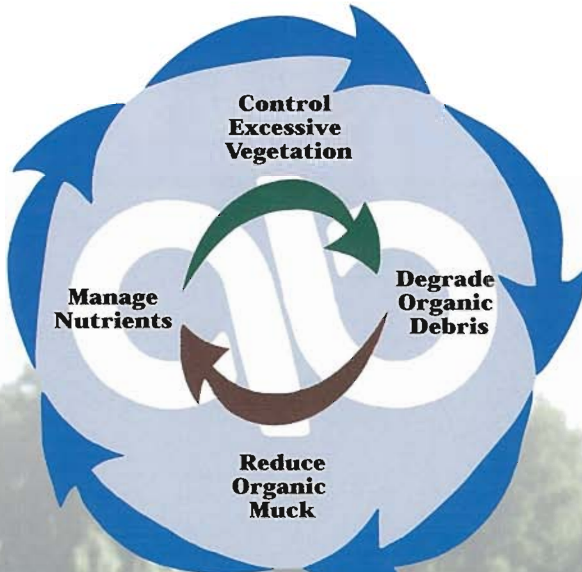

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Continued on page 20

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"Hey, I know the guy with the camera doesn't see me, especially if I pretend to be a plant." This reclusive American Bittern was photographed displaying its typical concealing behavior on the lower Oklawaha River. Photo by Jim Kelly

Aquatics

Contents

AQUATICS (ISSN 1054-1799): Published quarterly as the official publication of the Florida Aquatic Plant Management Society Registration No. 1,579,647. This publication is intended to keep all interested parties informed on matters as they relate to aquatic plant management particularly in Florida. To become a member of FAPMS and receive the Society newsletter and Aquatics magazine, send $20.00 plus your mailing address to the Treasurer.
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Understanding Fish Kills in Florida Freshwater Systems

This article was edited from the seventh in a series of educational publications produced by Florida LAKEWATCH © 2003 and The University of Florida - IFAS Extension, Information Circular 107 ***A Beginner's Guide to Water Management – Fish Kills***

For more information or to obtain copies of the entire 16 page publication, call 1-800-LAKEWATCH (525-3928) or (352) 392-4817. Free copies are also available for download from: http://lakewatch.ifas.ufl.edu/

Fish kill in a Central Florida Lake. Photo by Drew Leslie

Floridians are proud of the diversity and abundance of fish life found throughout the state, and for good reason. More than 225 different species of fish can be found in freshwater systems, including about 150 native species and approximately 75 non-natives. Of course, this doesn't even include the abundance of saltwater species! With such a variety to choose from, it's easy to see why Florida is considered the Fishing Capital of the World — a place where virtually every day, thousands of anglers take to the water to land a trophy bass, catch a delicious fish dinner or enjoy the therapeutic qualities that fishing has to offer. In fact, freshwater anglers contribute nearly two billion dollars to the state's annual economy.[1] However, anglers aren't the only people who care about fish. There are just as many individuals who enjoy feeding or watching them school under a dock. Some lake residents have even "adopted" or named individual fish that are seen on a regular basis. Still others feel good simply knowing that there are fish living in their neighborhood lake, pond, or canal, serving as indicators of the ecosystem's health. Such strong connections to the aquatic environment may help explain the concern that surfaces when reports of a fish kill appear in the local media — especially if large numbers of fish are involved. Often the first assumption is that something is terribly wrong with the lake or waterbody. Suspicions are raised as to whether human activity, such as a chemical spill, may have caused the fish to die. Sometimes these suspicions are warranted but often they are not. What many people don't realize is that the vast majority of fish kills in Florida are due to natural causes.

The Bad News

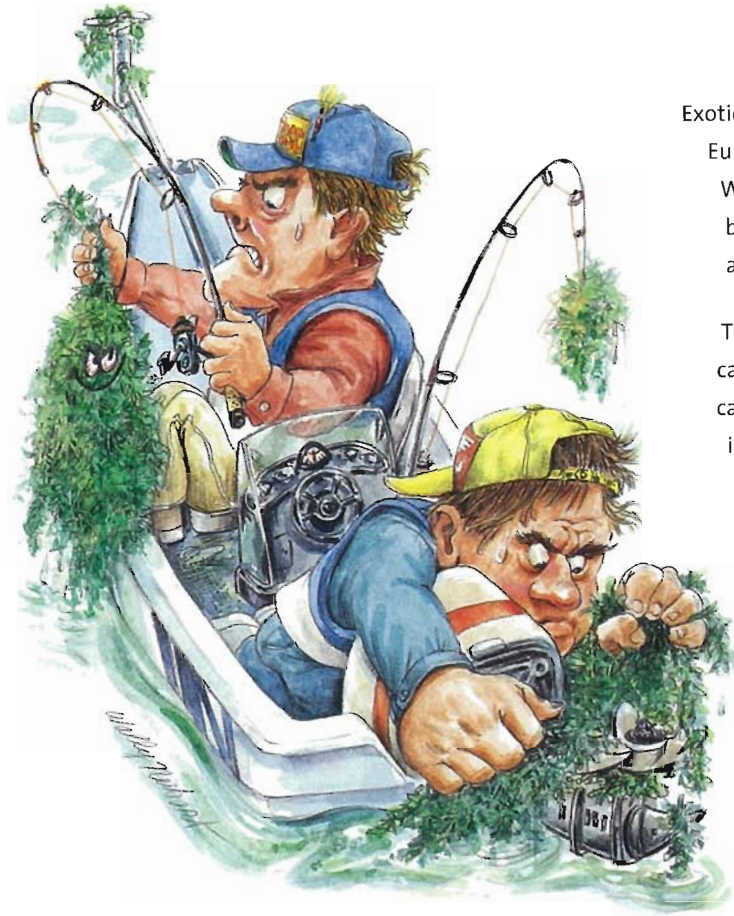
- Fish kills occur frequently in Florida and most of them are natural.
- It is difficult to predict when a fish kill will occur.
- Even if a fish kill is predicted, there is not much that can be done to prevent it, especially in larger waterbodies.

The Good News

- In the event of a fish kill, you may see a lot of dead fish but there are usually a lot more that are still alive.
- If water quality should change for the worse, there are often many refuges for fish to escape to.
- Because fish are known to lay many eggs, their reproductive potential is usually strong. As a result, they are generally able to rebound from a fish kill within a couple of years.

[1] *According to the National Survey of Fishing, Hunting and Wildlife-Related Recreation. U.S. Census Bureau. 2001.*

Too Many Weeds Spoil the Fishing



Exotic invasive aquatic plants such as Hydrilla, Eurasian Watermilfoil, Curlyleaf Pondweed, Water Chestnut and Water Hyacinth can be detrimental to a healthy fishery in lakes across the country.

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Naturally Occurring Fish Kills

Naturally occurring fish kills can be related to physical processes (e.g., rapid fluctuations in temperature), water chemistry changes (e.g., lack of oxygen or changes in the pH), or they can be biological in nature (e.g., stress from spawning activity, viruses, bacterial infection, parasites, etc.). Such processes are common to every lake in Florida and generally become lethal only after a fish is weakened by stress. As described later in this article, stress is usually caused by a number of factors — in addition to the daily challenge of living in an aquatic environment and continuously having to hide from predators. In Florida, the vast majority of fish kills are caused by one or more natural causes. The most common are low dissolved oxygen levels, spawning fatalities, mortality due to cold temperature, and fish parasites or diseases. On occasion, toxic algae blooms may be suspect. The following segments provide basic descriptions of these factors and how they can adversely affect fish health.

Low Dissolved Oxygen Levels

Fish absorb oxygen from the water as it passes over their gills. For optimum health, warm water fish generally require dissolved oxygen (DO) concentrations of at least 5 parts per million, also expressed as 5 milligrams per liter or 5 mg/L. Just like humans, fish can endure brief periods of reduced oxygen. However, if DO levels drop below 2 mg/L, they aren't always able to recover.[2] When concentrations fall below 1 mg/L fish begin to die.[3] The periodic depletion of dissolved oxygen in a lake or waterbody is by far the most common cause of fish kills in Florida. These events are easy to recognize because they usually affect many different sizes and species of fish, whereas cold temperature related or spawning-related fish kills tend to affect only one or two species. If it is a DO-related fish kill, large fish tend to be affected first and more severely than other fish. Another clue: small fish can be seen gulping or gasping for air at the surface just before a fish kill occurs. When it comes to understanding the dynamics of oxygen and water, the most important thing to remember is that the amount of dissolved oxygen found in an aquatic system changes constantly, day and night. It is affected by weather, temperature, the amount of sunlight available, and the amount of plants and animals living in the water. Each of these factors can influence the amount of oxygen released or removed from the water at any given time.

Oxygen enters water from two main sources:

The atmosphere: The same oxygen that we breathe from the atmosphere is also slowly and continuously being dissolved into our oceans, lakes, rivers, streams, and ponds through a process known as **diffusion**. Wind and wave action can accelerate this process.

Photosynthesis: Photosynthesis is a process whereby algae and aquatic plants use carbon dioxide, water, and sunlight to make their own food. Oxygen is a by-product of this activity. Therefore, as long as photosynthesis is taking place, oxygen is continuously being released into the water.

At the same time that oxygen enters the aquatic environment, it is also being removed by the following natural processes:

Biological activity in the water column – refers to the regular day-to-day functions carried on by various aquatic organisms in a lake including algae, aquatic plants, bacteria, fish, insects, zooplankton, etc. Just as you and I use oxygen from the air, these organisms are constantly using or removing oxygen from the water. This is usually not a problem during daylight hours

[2] *Dissolved oxygen refers to oxygen gas that is dissolved in water.*

[3] *Fish kill data reported to the South Florida Water Management District documents that 87% of the fish killed in South Florida (i.e, from 1991 to 2001) occurred when surface DO was 3 mg/L or less. Measurements were taken during or shortly after each fish kill event.*

because the algae and submersed aquatic plants generally produce a surplus of oxygen via photosynthesis. However, once the sun goes down, algae and plants are no longer able to photosynthesize and they become oxygen *consumers*, instead of oxygen *producers*. After a long night of limited oxygen production, the organisms in a lake are ready for some fresh DO.

Water temperature – affects how much oxygen water can hold at a given time. As a general rule, warm water holds less oxygen than cool water.[4] In fact, not only does warmer water hold less oxygen, it also speeds up a fish's metabolism. Of course, this dynamic puts fish in double jeopardy; as the water becomes warmer, fish need more oxygen for respiration,[5] but are getting less because warm water holds less oxygen.

Decomposing aquatic plants and/or algae – can result in the loss of oxygen in a waterbody and it works like this: once the plants or algae die, a feeding frenzy is often triggered within the detrital aquatic community,[6] as bacteria begin to break down or "decompose" the dead vegetation. The increased activity can result in a loss of oxygen because these organisms are working harder and therefore using more oxygen. If there is a large amount of dead vegetation or algae, such activity can result in a severe loss of dissolved oxygen and, consequently, a fish kill. Lakes or ponds with heavy populations of aquatic plants or algae are more susceptible to this type of event and can result in large numbers of dead fish. That is why, when using chemicals (i.e., algicides or herbicides) to remove algae or aquatic weeds from a lake, it's recommended that treatments be staggered in order to avoid large amounts of algae or plants dying all at once.[7]

Lake turnovers – generally occur in the fall but can sometimes occur in the summer. During hot weather, the surface water of a lake warms much faster than deeper water. This results in a temporary layering effect, with warm water on top and cool water underneath. This layering is referred to as stratification. Because the top layer has constant access to the atmosphere, it tends to have more oxygen than the bottom layer — even though it's warmer.[8] If a heavy wind or cold rain should occur during these conditions, the stratification may be broken, causing the two layers to mix. Once this happens, oxygen-rich surface waters are suddenly mixed with the low-oxygen bottom waters. If the volume of low oxygen water (i.e., from the bottom of the lake) is much greater than the oxygen-rich surface layer, this mixing action can result in low DO levels throughout the water column, and potentially result in a fish kill.

To summarize: Although oxygen depletions can happen at any time, they are most likely to occur during warm summer months due to the factors described above. A combination of hot weather and cloudy skies can be particularly deadly for fish, as the decrease in sunlight (i.e., from cloud cover) makes it difficult for algae and plants to photosynthesize. The reduction in photosynthesis results in a decrease in oxygen being released into the water column. When overcast skies persist for several days, oxygen levels can become severely depleted.

Heavy thunderstorms can also have an adverse effect on oxygen levels, especially after extended periods of dry weather or during hot weather. If conditions have been dry for a long time, heavy rains tend to wash large amounts of organic matter such as dried leaves, grasses, etc. into nearby canals, lakes, and ponds. As bacterial organisms begin to decompose the new material, oxygen is used at a faster rate than normal. This can be a problem during hot weather as there is less oxygen in the water.

Spawning Fatalities

Another type of fish kill event that is both natural and common in Florida waterbodies occurs after fish spawning activities. This is usually due to exhaustion from courtship behavior, nest building, and the release of eggs or milt. Fish have also been known to suffer fatal injury from defending their young. During and after spawning, fish are often quite weak and any change in the environment can stress them significantly and lead to death. These type of events are most common in the springtime and early summer when the majority of the fish are spawning.[9]

They are generally identified by the deaths of adult fish (only), belonging to one or two different species.

Mortality Due to Cold Temperatures

Fish kills can also be the result of a dramatic drop in air, and consequently, water temperature. This type of event is easily identified because it generally happens after extended periods of cold weather and almost all of the dead fish will be cold intolerant species. In almost every instance, these cold intolerant species are "exotic" fish that have accidentally been introduced to Florida waters. One example is the blue tilapia (*Tilapia aurea*) from Africa's Nile River. This fish was inadvertently introduced into Florida waterbodies in 1961 and is now successfully reproducing in 18 counties. Because they are from a tropical region of the world, blue tilapia don't fare well in cold temperatures; they stop feeding when water temperatures drop to about 60 degrees Fahrenheit and die when it reaches approximately 45 degrees.

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4 *There are times when cooler water may not necessarily hold more dissolved oxygen than warm water. See* ***Lake Turnover*** *section described on page 5.*

5 *(i.e., the act of breathing)*

6 *(i.e., microbes and/or insects that feed on rotting vegetation and debris)*

7 *A Beginner's Guide to Water Management - The ABCs (Information Circular 101). 1999. Florida LAKEWATCH. University of Florida/ Department of Fisheries and Aquatic Sciences. Page 12.*

8 *While cooler water has the potential to hold more oxygen, there are times when dissolved oxygen levels are lower in cool water — especially at greater depths where there is no access to atmospheric oxygen and photosynthesis is limited due to a lack of sunlight.*

9 *Some fish spawn year round in Florida, but the peak season is generally from January through April.*

Those who worry about the further spread of exotic tropical fish species can take some comfort in knowing that their distribution is often naturally limited by their sensitivity to low temperatures. This natural control mechanism was recently demonstrated at Lake Alice, a small waterbody on the University of Florida campus in Gainesville in North Central Florida. For several years, the lake supported a population of blue tilapia estimated to be around 12,000. However, in early January 2001, a severe cold front passed through Gainesville bringing temperatures that were considerably colder than the tilapia's native African habitat. Within a week, dead tilapia began to float to the surface. By the middle of the month, thousands of these fish had died, while native species survived the cold snap just fine. Several more cold fronts have effectively reduced the tilapia population to almost nothing.

Stress in Fish

As you've read, there are many factors that can contribute to a fish kill. However, stress seems to be a common element linked with virtually every one of these events. The term "stress" is used to describe the physical changes that fish experience as they adjust to a changing environment. While it may not be the actual cause of disease or death, it is always a predisposing factor. As with humans, there are numerous degrees of stress and a fish can recover from many of them, especially if it can remove itself from the negative events it is experiencing. However, if it cannot escape, or the events increase in severity or duration, the fish may be pushed beyond a level from which its system can recover. The typical stresses that a fish may experience on a daily basis, such as predator/prey interactions, are natural situations that fish are designed to deal with. However, continuous stress tends to break down a fish's immune system and can lead to disease or death. Examples of continual stressors include poor nutrition, poor water chemistry, and overcrowding. Multiple stresses occurring at the same time can have a magnified effect and often represent the fatal blow to a fish's health.

Diseases and Parasites

Fish diseases (i.e., from viruses, bacteria, and fungi) and parasites (i.e., protozoans, crustaceans, flukes, and worms) occur naturally in Florida lakes and under certain circumstances, fish can contract one or more of these afflictions. Of course, a healthy fish is usually able to fend off such problems, but if a fish is weak from spawning or from extreme water quality conditions, it has a much greater chance of getting sick or possibly dying. Fish infected with parasites or diseases may have physical clues on their bodies or they may display abnormal behavior. Some physical clues can be obvious, such as open sores on the body, missing scales, lack of slime, or strange growths on the body, head, or fins. If a fish is large enough (e.g., a largemouth bass), the careful

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SePRO Corporation 11550 North Meridian Street, Suite 600, Carmel, IN 46032 observer may even notice parasites crawling on its skin or gills. Abnormal behavior may include swimming weakly, lazily, erratically, or in spirals; scratching or rubbing against objects in the water; twitching, darting, or convulsing; failure to flee when exposed to fright stimuli; gasping at the water surface or floating head, tail, or belly up. These types of fish health problems are perhaps a little more difficult to spot in the natural environment whereas fish farmers are all too familiar with it. In channel catfish aquaculture ponds, for example, a protozoan known as *Aurantiactinomyxon ictaluri* is known for causing the dreaded Hamburger Gill Disease. In some instances, it has killed up to 100% of the fish in an infected pond. Fish with this particular problem may exhibit a reduction in feeding habits and can be seen swimming lethargically.

They may also be gasping for air at the surface and frequently will congregate around aeration equipment. Their gills will be swollen and mottled with red and white colored streaks, closely resembling ground hamburger meat, hence the name.

Toxic Algae Blooms

The appearance of large amounts of algae or scum floating on the surface of the water is often referred to as an "algae bloom" or "algal bloom." Such occurrences can be smelly, unsightly, and — depending on the species of algae — the color of the water may even change. In some instances, a number of dead fish may be seen floating on the surface or washed up on the shoreline. As alarming as these events may seem, there are several factors to consider before assuming that an algal bloom is toxic:

- In Florida's freshwater systems, there are relatively few species of algae that are known to produce toxins.[10] The most common species found here are the blue-green algae *Microcystis*, *Cylindrospermopsis*, *Anabaena* and *Aphanizomenon*, as well as the microflagellate *Prymnesiam*.[11] It's important to note that not all of the species within these algal groups produce toxins; those that do, produce toxins in varying amounts, depending on prevailing conditions.
- While toxins produced by these algae have the potential for killing fish, there are very few cases that have been definitively linked to toxins. (This will most likely remain an important focus of research for years to come.)
- Algae blooms are a natural component of nutrient-rich lakes and rivers, particularly those with high levels of nitrogen and phosphorus.
- Algae blooms are fairly common in Florida either because of natural geologic conditions (nutrient-rich soils) or human induced increases in nutrients.
- It's thought that most algae-related fish kills are the result of oxygen depletion, as opposed to toxicity problems.

Human Induced Fish Kills

There is no doubt that human impacts can lead to fish kills. However, in the United States, it is also true that point source pollution problems have been reduced dramatically since the turn of the 20th century, or even as recently as the 1960s, when raw sewage and industrial waste were routinely dumped into rivers, lakes, and oceans. (Remember the Hudson River fires?) In recent decades such practices have been virtually eliminated. Nowadays, if a human-induced fish kill does occur, it's usually the result of contaminants unintentionally being spilled or leaked into a nearby waterbody. Obviously, the goal should be to prevent these occurrences in the first place. But accidents happen and they can happen in any number of ways: Highway accidents involving tanker trucks full of fertilizers or other toxic substances have resulted in chemicals spilling into nearby waterbodies. Barges have been known to run into things, rupturing storage tanks and releasing oil or other contaminants. Gas pipelines have also been known to crack and leak oil into various aquatic environments. In some instances, a spilled substance may not even be toxic, but if enough of it is introduced into a system, it can be detrimental in another way such as causing a shift in water temperature or a change in pH. As far as toxic spills are concerned, the effects of such an event often depend on the toxicity of the spilled substance and the surface area and volume of the waterbody. In other words, if a lake is large enough, it may be able to dilute the substance enough so that aquatic organisms, including fish, are able to avoid any detrimental effects. Of course, this isn't always the case. One example of a catastrophic human-induced fish kill involved a phosphate plant in Mulberry, Florida in December 1997. Nearly 60 million gallons of acidic process water from the plant was accidentally dumped into Skinned Sapling Creek, a tributary to the Alafia River. In five days, the spill traveled 36 miles down river and changed the pH of the water from around eight to less than four.[12] A fish kill occurred along that entire stretch of river, killing an estimated 1,300,000 fish. Fortunately, such occurrences are rare.

Sometimes, human-induced fish kills can occur from the sheer amount of foreign substances entering a waterbody. When this happens, fish die mostly from low oxygen levels that have resulted from an increase in biological activity in the water. A related example of this involved an explosion at the Wild Turkey whiskey factory located along the banks of the Kentucky River, near Lawrenceburg, Kentucky. The explosion resulted in many thousands of gallons of bourbon flowing into the river. Officials were unsure whether it was the bourbon that killed the

[10] *Coastal residents are perhaps familiar with toxic-algae related fish kills that occur periodically in coastal waters (i.e., in the form of red tides).*

[11] *A class of single-cell organisms such as a flagellate protozoan or alga.*

[12] *In addition to their sensitivity to changes in temperature and dissolved oxygen, fish can also be detrimentally affected by rapid changes in the pH of the water.*

fish or a lack of oxygen from the millions of aquatic microbes that rapidly began to devour the liquor, essentially sucking all the dissolved oxygen from the water. Hundreds of thousands of fish died in that event. If a human-induced spill or fish kill event should occur, there are often clues that will help bring attention to the problem: A "film" or "slick" can sometimes be seen on the surface of the water, or the color or clarity of the water may change.[13] Strange odors might also be noticeable or there may even be more obvious evidence such as large containers of the substance sitting near the shoreline. A thorough investigation of the local area, along with written observations of changes in water quality, can direct investigators to the possible contaminating source. Observers should look for evidence of other wildlife species being affected such as birds, frogs, snakes, turtles, etc.

13 *An oily sheen on the water is not always an indication of a human-induced spill. There is a naturally occurring algae, known as Botryococcus, that produces an oily substance that can be seen on the surface of the water. In Florida, Botryococcus algae blooms are fairly common, especially during the summer months. Its presence has caused some alarm among lakefront citizens, as the algal cells are red or burnt orange in color and, in large enough concentrations, they have been known to temporarily change the color of a lake from green to orange. Also, in some instances, it will look very much like a gasoline spill or oil slick.*

What You Can Do If You Observe a Fish Kill

- Record the date and approximate time you first noticed dead fish.
- Observe and record the weather conditions from the past three or four days (e.g., temperature, amount of rainfall, cloud cover, wind strength and direction).
- Record any changes in the color of the lake water (e.g., did the water change from green to brown or black?).
- Record the type of dead fish, by species name, if possible.
- Record the number of dead fish and, if possible, categorize them by species.

Note: If the dead fish are too numerous to count, try to estimate the number by first counting the number of dead fish in a 10-foot X 10-foot area. Then estimate the total distance along the shoreline and out into the water in which dead fish are present. These numbers can be used to estimate the extent of the kill.

- If possible, take a few minutes to study the appearance of the dead fish and record the following observations:
  - — Size, to the nearest inch;
  - — The condition of the bodies (e.g., thin, bloated);
  - — Are one or both eyes normal, sunken in, or popped out ?
  - — Are the fins clamped down, bloody, or frayed?
  - — Are the gills discolored, bloody, or frayed?
  - — Are there lesions or growths on the fish?
  - — What else looks abnormal on the fish?
- Talk to your neighbors. Ask them if they've noticed anything unusual about the lake in the past few days. Were fish gulping air at the water's surface? Were there unfamiliar containers near the shore? Was there a "film" or "slick" present on the surface of the water? Were there any strange odors coming from the lake?
- Call the Florida Fish and Wildlife Conservation Commission (FWC) Fish Kill Hotline to report the event and they will pass it along to the appropriate regional biologist or enforcement officer.

FWC Fish Kill Hotline
(800) 636-0511

Florida's 24-hour Hazardous Substance Hotline
(800) 320-0519 or (850) 413-9911

Acknowledgments

Many thanks to UF/IFAS fish veterinarians, Dr. Ruth Francis-Floyd and Dr. Allen Riggs, for their editorial contributions and review of this material. Also, many thanks to Dr. Ed Phlips for his contributions on toxic algae.

Managing Natural Aquatic Plant Communities In Manatee Springs:

The Effects of Manatee Grazing, Nutrient Pollution And Flooding

(Above) Manatee Springs run historically supported dense growth of Vallisneria americana and other aquatic vascular plants. (Above right) Spring systems support dense SAV communities that provide valuable forage for manatees and other large aquatic grazers.

by Kent Smith and Ron Mezich
Florida Fish and Wildlife Conservation Commission

Aquatic plant management efforts generally focus on maintaining or reestablishing a native aquatic plant community in those systems where cultural eutrophication or non-native species invasions have altered the historic floral community. When nutrient pollution or exotic species affect our waters, they often create systems that are low in diversity, non-representative of natural communities and/or are algae-based rather than macrophyte-based. Impaired systems such as these are much less resilient when natural disturbances, such as large grazing populations or floods affect the abundance and distribution of remaining aquatic flowering plants. This is especially true if the communities persist in a confined area with unique water quality conditions relative to adjacent waters such as is found in spring runs.

Manatee Springs in Dixie County, Florida is one such system. This spring is managed as part of the Florida State Park system as Manatee Springs State Park. The main spring is a first magnitude spring* that delivers 91 million gallons of artesian spring water into the lower Suwannee River each day. The spring run is approximately 400 meters long by 20 meters wide, and has crystal clear waters that average about 1.5 meters in depth with a constant temperature of 23°C. This system has supported an extensive tapegrass (*Valisneria americana*) community that flourished along the length of the run. Submerged aquatic vegetation in the run included other species of flowering plants and an increasing amount of green algae. In the fall of 2000, a group of up to 22 manatees entered the spring and consumed much of the vegetation in the run over a 10 day period. Smaller numbers of manatees had been observed feeding on vegetation in the run in past years during the cold season, but this was the largest group of foraging manatees ever reported from this system. Manatees were first documented in the spring run by John Bartram in 1766 a (Bartram, 1766 and 1791). These large herbivorous aquatic mammals use the warm spring waters as a refuge from the cold river waters during the cold season. Manatees generally enter the spring run early in the cold season, but remain in the spring plume at the mouth of the run later in the season or migrate south before dispersing during the warm season. Regional populations of manatees have been documented to reduce submerged aquatic vegetation (SAV) abundance when adequate numbers of these large herbivores aggregate in a given area (Packard, 1981 and 1984; Lefevbre and Powell, 1990; Provancha and Hall, 1991; Lynn

**first magnitude springs are those that flow at a rate of over 100 cubic feet per second*

Lefevbre U.S.G.S. Sirenia Project, Gainesville, FL, and Jane Provancha, Dynamac Corporation, Merritt Island, FL, unpublished data). Hartman (1971) observed manatees tunneling through dense exotic SAV beds in Crystal River and found individuals which would return to specific patches of eelgrass, which were reduced in biomass, but would recover after manatees left the system. Bengston (1981, 1983) found that any aquatic plants found in Blue Spring, Volusia County were quickly consumed by manatees seeking thermal refuge in this system.

In the recent past, only a few manatees were observed grazing on the healthy aquatic vegetation communities in the Manatee Springs run, but monitoring of the manatee population using the run in the late 1990s showed an increase in the abundance of manatees in the system (**Figure 1**). Surveys of the grazed vegetation showed only remnant populations of small new plant growth or cropped shoots after the manatees left the run. Within a month of the reduction of macrophyte cover, the already abundant green algae *Vaucheria sp.* began to dominate the aquatic plant community and cover the bottom of the run. This may be due to the almost four fold increase in nitrate concentrations (from 0.4 mg/l in 1946 to 1.5 mg/l in 2003) in spring waters attributed to agricultural and municipal activities within the spring recharge basin. The system remained dominated by this dense green algae monoculture until the late summer of 2001, when the tapegrass community dramatically returned to its former abundance over a short 2 month period. Despite this rapid community shift, green algae remained a significant component of the flora in the spring run and covered most of the larger macrophytes.

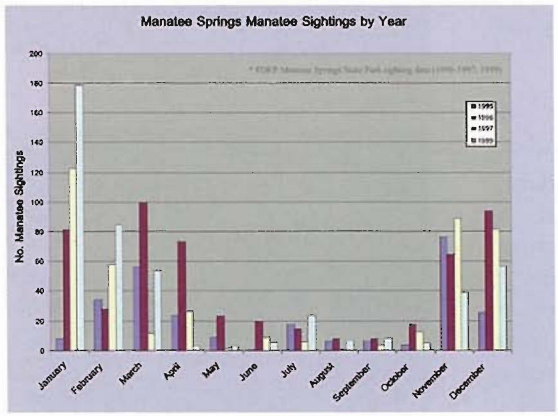


Figure 1: Manatee Springs in the Florida Big Bend region shows the seasonality typical of a warm water refuge use by manatees. Sighting data indicate the cold season (November-March) as the period of peak manatee use for the spring run.

Based on these observations and at the request of the Park manager, we set out to examine the effect of seasonal foraging by a small population of manatees on the tapegrass community in Manatee Springs. Our goal was to determine, 1) if seasonal manatee foraging reduced tapegrass abundance, 2) if the tapegrass community recovered during the growing season, and 3) if limited caging of areas of tapegrass could be used as a management tool to protect mature stands from grazing and provide the aquatic plant community with a "jump start" to seasonal recovery.

Methods:

We designed a limited study that was based on excluding manatees from small caged areas that would be monitored before, during and after the cold season to allow comparisons between grazed (open controls) and ungrazed (caged treatments) areas. Due to the sensitive nature of the State Park and small size of the spring run, we established a series of 3, 1.25 x 1.25 m cages to exclude manatees and other large grazers from an area of the run with similar depth (0.7-0.85 m) and sediment characteristics along a bank adjacent to the northern shoreline of the lower run (**Figure 2**). Cages were constructed out of steel garden fence posts inserted into the sediment with 1/8" steel garden fencing of 3" diameter rectangular mesh attached with cable ties to a 6-8 post frame (**Figure 3**). The cages were constructed so as to allow a central $1m^2$ area of eelgrass to be sampled without edge-effect interference. As light limitations and shading effects were a concern, cages were constructed to rise to the surface of the water to preclude access by grazers from above and still remain uncovered. Control areas were established at a distance of 40 cm down current from each cage. Locations of the controls and cages were not randomized, due to the distribution of tapegrass along and limited size of the shallow bank. This region of the run was also the only area within the run of similar depth and sediment characteristics where our replicate design would fit. A .25 m^2 quadrat constructed of 1 inch diameter PVC pipe and divided into four equal squares with neon-orange nylon grass trimmer cord was used to sample the central area of the cages and controls. Sampling both cages and controls consisted of counting all shoots within each of the 4 quadrats and haphazardly measuring the total length and width of 5 blades of tapegrass within each quadrat to obtain an estimate of available plant volume [volume (m3/0.25m2) = no. total shoots x mean blade length (m) x blade width (m) x 0.07 m or 0.03 m (average shoot "width" for large or small plants)] for each sampling period (**Figure 4**). Non-destructive sampling was conducted on a monthly basis from November 2002 to May 2003. Data obtained for pre-and post-grazing periods were tested for statistical assumptions and analyzed using single factor ANOVA statistical software (Excel, Microsoft, Inc.).

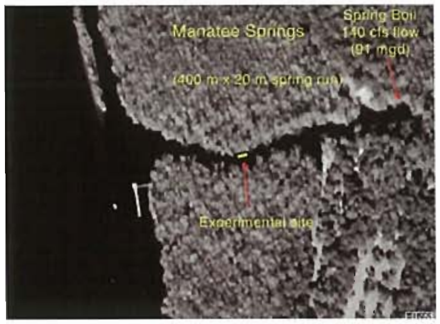


Figure 2: Map of the study area in Manatee Springs run.

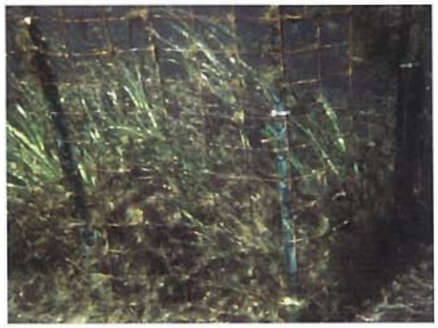
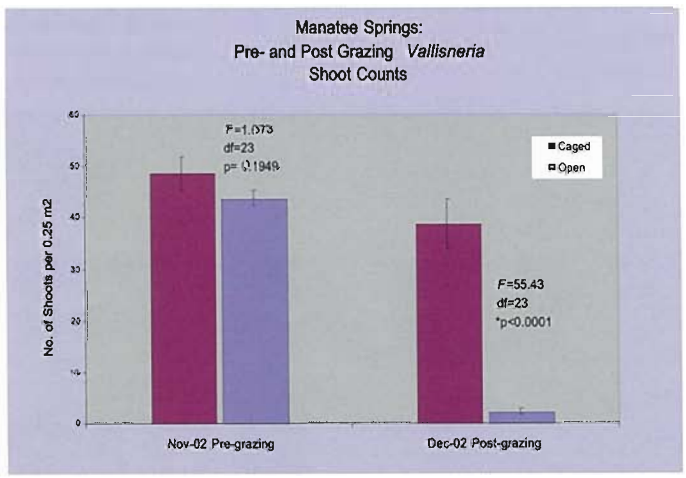


Figure 3: Experimental cage with tapegrass protected from large grazers.

Figure 4: Sampling involved measuring individual blade length and width for 5 haphazardly selected blades in each 0.25 m2 quadrat. The 0.25 m2 quadrat used for measuring shoot abundance is visible in the adjacent background.

Figure 5: Tape grass shoot counts before and after grazing by manatees. During initial set-up and prior to manatees entering the run and grazing, Vallisneria shoot counts were statistically similar between open and caged treatments. After extensive manatee grazing, open plots demonstrated a 95% reduction in plant abundance compared to caged plots. Error bars are 1 SE.



Results:

Manatees entered the spring run and began foraging on available tapegrass within days of our preliminary sampling effort in November of 2002. A group of 14 manatees remained in the small run area over a 10 day period to escape the effects of a series of cold fronts passing through north Florida during the last two weeks of November. Data for shoot counts for the 3 cage and 3 control treatments were found to be statistically similar and were pooled for a comparison between the pre- and post grazing sampling

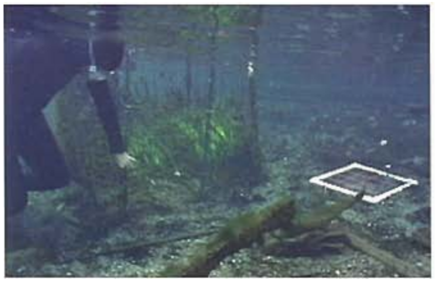


Figure 6: Cages protected enclosed stands of tapegrass, while grazed areas outside the cages were vulnerable to the effects of sustained manatee foraging.

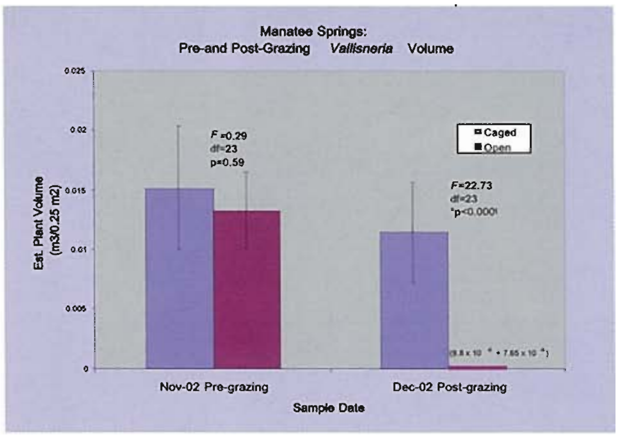


Figure 7: The same relationship as that for tapegrass shoot counts is also evident for estimated plant volume, indicating a significant reduction in overall plant biomass post-grazing. Estimated plant volume was reduced by 99% when open plots were compared to caged plots after manatee grazing.

periods of November and December 2002. Tapegrass shoot counts in the open control areas and the caged treatments were not significantly different during the November sampling period (**Figure 5**). One month later in December, after sustained manatee grazing in the spring run was observed, tapegrass shoot counts were significantly reduced (by 95%) in the open grazed controls when compared to caged tapegrass areas (**Figure 6**). The same relationship is apparent in the estimates of plant volume. Tapegrass volume in the open grazed controls was significantly reduced (by 99%) when compared to the estimated volume of tapegrass within the cages (**Figure 7**).

In order to assess the possible seasonal recovery of the tapegrass community, monthly sampling continued through May of 2003. Two of the cage treatments were compromised by manatees, which lifted the cages up from the bottom and grazed on the formerly protected tapegrass, by the January sampling effort. Only one uncompromised cage remained after this time. Although no statistical inferences can be made due to the loss of the other cage replicates, the trend for shoot counts in the remaining open grazed control plot showed a recovery in number from December through February (**Figure 8**). This trend was also observed in the cage treatment. During the January and February sampling efforts, remaining plants within the cages

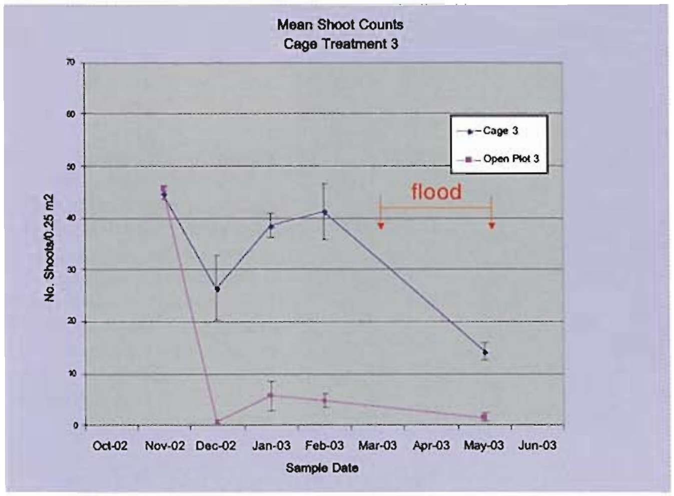


Figure 8: Treatment 3 was the only cage not accessed by manatees to some degree during the study period. After a slight recovery trend, tapegrass plants still succumbed to the effects of flood waters as demonstrated by the reduced shoot counts in the May sampling period. This was presumed to be largely due to light limitation.

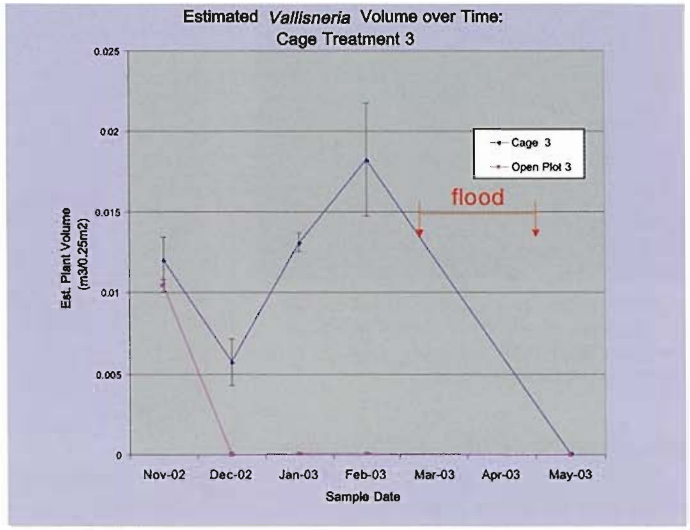


Figure 9: Estimated plant volume in Treatment 3 showed an initial trend toward recovery within the cage after manatee grazing. Estimated volume then declined to near zero after the flood event.

produced new apical rhizomes and new shoots that in two of the cages, extended outside the cages onto the adjacent hydrosoil. In the uncompromised cage, 25 new shoots were observed around the perimeter of the cage in February.

Tapegrass volume showed a trend similar to that for shoot counts within the remaining cage, but plant volume in the open grazed control did not (**Figure 9**). Declines in shoot counts and tapegrass volume in the remaining cage treatment and associated control thereafter resulted from the breaking of a long standing drought with 20 inches of rainfall within a month, which forced over 2 meters of darkly tannic stained water (Secchi disc depths averaged 0.7-0.9 m) over the study area for over 2 months (**Figure 10**). Sampling could not be conducted during this time and commenced again in May, at which time only a small number of residual tapegrass plants remained throughout the study area. The study sites appeared scoured during this time with little remaining vegetation of any kind apparent. Sampling in August revealed 8 plants in the one remaining caged treatment square meter. All plants had blade heights of 5-15 cm and widths of 4-8 mm with clusters of between 3-5 blades per plant. The study area and most of the spring run were covered in a 20-50 cm deep blanket of green algae (*Vaucheria* sp.).

Discussion and Recommendations:

The relatively large number of manatees feeding in the confined area of the spring run for an extended period of time during November and December of 2002 significantly reduced the physical amount of tapegrass within the open areas of the study site. These findings are similar to those of Hauxwell, et al. (2004), who attempted to use cages to protect planted stands of tapegrass from large grazers including manatees in Kings Bay, Florida. In the latter study, transplanted tapegrass plants were absent from 80% of open plot treatments, which were subject to grazing by the abundant cold season population of manatees using the springs network in Kings Bay, one month after initial planting. Tapegrass plants were, however, relatively abundant and continued to grow in all of the completely fenced plots at the same time in the Hauxwell and coworkers study. Caging proved an effective means of preserving patches of mature tapegrass from manatee and other large herbivores in both the Kings Bay study and our Manatee Springs study (at least for the first month in the latter case). In our study, the cages were designed to be

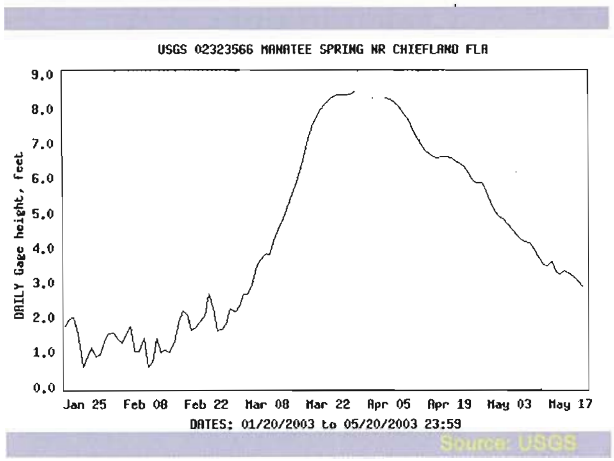


Figure 10: Heavy rainfall of greater than 20 inches beginning in mid-February caused the Suwannee River to flood to approximately 2 m above mean river stage. This flood brought dark tannin-stained and turbid water into Manatee Springs run and over our experimental sites. On March 17, 2003, the spring itself began to flow "black." Stained water issued from the spring boil until May 10, 2003. This led to decline of all vegetation in the spring run including benthic algae. Secchi disc depths over the experimental sites were 0.7 m when sampled in mid-March.

as light and therefore inconspicuous as possible in order not to be obvious to State Park visitors, and as such, they were not sturdy enough to completely prevent manatees from accessing the tapegrass within all but one of the treatments.

Although we can not definitively determine if tapegrass community recovery was occurring after manatees grazed in and left the spring run, the data from the remaining cage treatment and its associated control do indicate that the plants were beginning to put forth new growth and expand. We documented increasing numbers of shoots within the cages and adjacent control areas. The same was true for plant volume estimates, but volume had been reduced to a level in the open control that did not allow detection of measurable recovery over the sampling period.

Manatees and other large grazers, such as the numerous aquatic turtles (*Chrysemes spp.*) and non-native grass carp (*Ctenopharangeodon idella*) that we observed in the run, can act to alter the submerged aquatic vegetation community in Manatees Springs and other spring systems. Grass carp in Manatee Springs come from the Suwannee River, where individuals escaped from stocked systems within the drainage basin of the river (Dave Eggeman, Florida Wildlife Commission, pers. com.). Foraging activity of large grazers stimulates increased productivity and maintains diversity in targeted plant communities. Their actions also increase plant biomass turnover rates and nutrient cycling. Large grazers, despite their beneficial ecological actions, can more negatively affect systems already placed under stress.

Recovery of the tapegrass community is far more problematic than we first recognized. Manatee Springs has experienced an almost 4 fold increase in nitrate concentrations in spring waters. This has led to changes in the community structure of the system, favoring an algae-based plant community over one dominated by tracheophytes. The advantage provided to the green algae community shows in the observed complete dominance of *Vaucheria sp.* as a dense blanketing coverage throughout the run. Grazing by manatees and other foraging animals leaves viable plant material behind from which a community can regenerate. Regeneration is, however, greatly reduced by the effects of competition with other species and natural disturbances. Green algae was observed covering small tapegrass plants left behind after manatees were finished grazing. The thickening layers of algae blocked light from getting to the blades of tapegrass reducing the potential for photosynthesis and growth. There are also likely issues related to anoxia above the sediment surface, where decaying dead algae depletes dissolved oxygen needed for tapegrass survival and growth. The effect of continued non-native grass carp grazing during a period when other native large grazers would be absent from the system also reduces the rate or likelihood of recovery. We observed schools of over 20 grass carp of about a meter in length feeding along the study site at various times. Grass carp consume large amounts of aquatic vegetation and can greatly affect the abundance and biomass of native plant communities. In addition to this, a major long-term flooding event, which all but eliminated available sunlight to benthic plants, caused all vegetation to disappear from the main channel and study area of the spring run. The result was that the bottom of the run was virtually devoid of both tracheophytes and algae during our survey of the run in May 2003 shortly after the flood abated and clear spring water once again flowed the length of the spring run.

Springs are often viewed as stable systems that support plant communities in relative abundance. Environmental conditions in Manatee Springs are far from stable at a seasonal scale, however. This greatly influences the composition and biomass of the standing aquatic plant community. Grazing, nutrient contamination and inter-annual rainfall conditions act in concert to control the aquatic plant community dynamics. Our study does, however, indicate management can address one element of this ecological interaction.

Small areas of cages (10s of square meters in area) designed to keep manatees and other large grazers at bay can be established to protect established mature tapegrass and perhaps other natural macrophyte beds. The plant communities within strategically placed arrays of such

My Favorite Airboat "Story"

***Editor's note:** If you have a favorite airboat adventure you'd like to share please contact Judy Ludlow, Aquatics Editor. Airboats are an integral tool of our trade, and demand respect. Many of us have "favorite" stories that, if shared, may educate and enlighten others so that they may avoid the situation you were in, or learn new tricks to get out of a jam!*

Favorite repairs

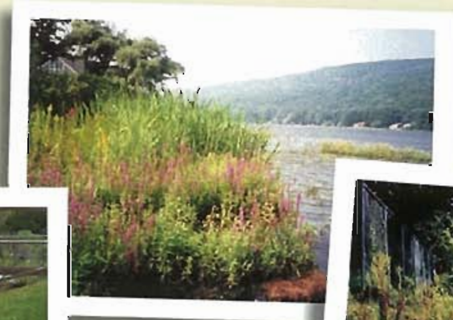
Once I had to siphon some gas into a jar (not beer bottle) because my fuel pump busted. I held the jar up over my head to feed the fuel into the engine and putted all the way back to the ramp.

Aw c'mon just one more trail...

One late summer afternoon, while surveying 448,000 acre Lake Okeechobee, two DEP biologists, one rookie, one veteran, spotted an un-surveyed trail into the marsh. After completing a bat-turn in the rim canal that nearly swamped them, they raced into the marsh down the trail, which just happened to be directly across from Uncle Joe's bar. Meanwhile storm clouds were building, but they were far off (yup, you've heard that one before!). Having gathered the needed data they turned to head back out, that is until the boat died. Darn, there goes the pizza dinner! Performing every first aid trick in the book, the frustrated biologists could not start the boat. That distant storm was now crackling over their shoulders and being the tallest, metal object for miles around they wisely decided to abandon ship. Through the marsh they marched in deepening waters until they stopped at the edge of the rim canal. The bar patron who ferried the biologists to safety told them they were standing on the very corner that a 13 foot 'gator nicknamed ol' Joe likes to lie on. "Oh sure" they thought to themselves with a grin, but as the two biologists finally left, there was ol' Joe, seemingly all of 13 feet, sitting there, on that very corner, hungry. "Oh %$#&*" they thought to themselves with a grimace! Of course, these biologists were luckier than the two other DEP biologists, one rookie, one veteran, who spent half that night feeding mosquitoes in the company of their dead airboat, on the banks of the Old Moorehaven canal. And yet, to them, a day in the field is still better than a day in the office!!

Untreated

Treated



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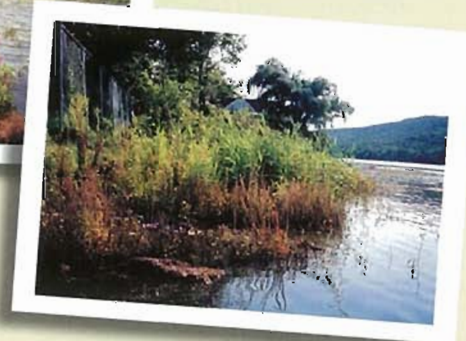

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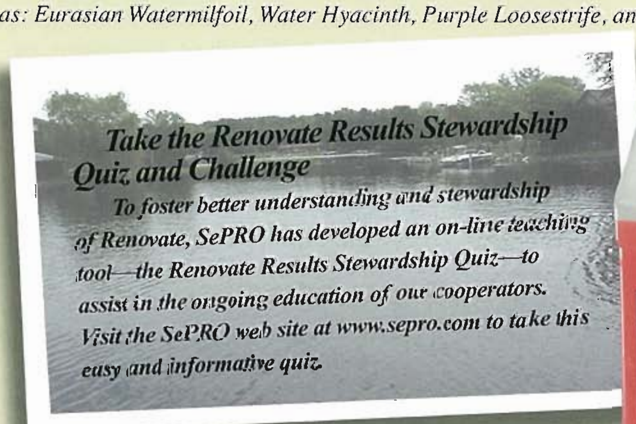

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References available upon request.

Call for Papers

Continued from page 3

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Interference of Natural Regulation of the Aquatic Weed Mosquito Fern (*Azolla caroliniana*) by the Red Imported Fire Ant

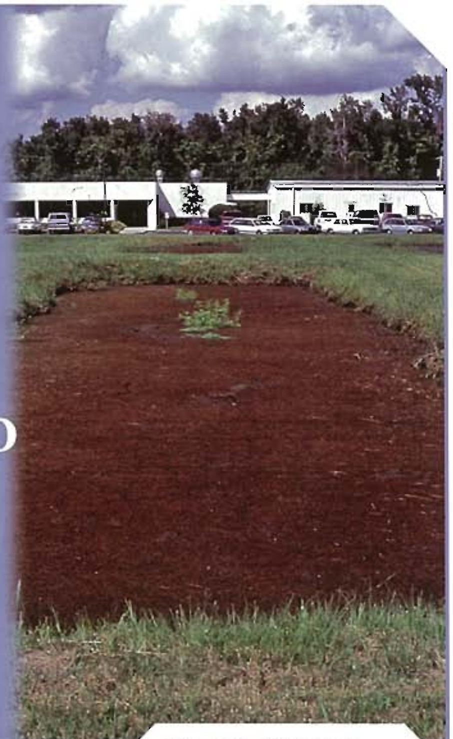

Figure 1. Research pond at the UF/IFAS Center for Aquatic and Invasive Plants completely covered by a thick mat of mosquito fern, Azolla caroliniana.

by J.P. Cuda[1], A.S. Brammer[1], R.M. Pereira[2] and M. Broza[3]

Introduction

The free-floating native macrophyte *Azolla caroliniana* Willd. (Pteridophyta: Azollaceae or Salviniaceae), also known as mosquito fern, watervelvet, waterfern, or simply azolla, can be a nuisance when it forms large floating mats that completely cover a pond or a lake (**Figure 1**). Fortunately, mosquito fern has several insect natural enemies in Florida that usually keep it from proliferating to that extent. However, we have observed that these same natural enemies often fail to keep the plant in check, and the only recourse has been to treat the pond repeatedly with an approved aquatic herbicide such as diquat or fluridone (Thayer et al. 2003). In this study, we show how a basic understanding of the process of natural regulation may help to alleviate the mosquito fern problem in some heavily infested freshwater lakes and ponds.

Distribution, Biology and Importance of Mosquito Fern

Mosquito fern inhabits aquatic ecosystems all over the southeastern U.S., and occurs throughout the state of Florida although it is less common in the Panhandle (**Figure 2**). Mosquito fern inhabits lakes, ponds, ditches and slow-moving streams, and it is commonly found in alkaline, nutrient-rich lakes and ponds (Hoyer et al. 1996).

[1]*Entomology & Nematology Department, PO Box 110620, Institute of Food & Agricultural Sciences, University of Florida, Gainesville, FL, 32611-0620.*
[2]*Current address: USDA, ARS-CMAVE, 1600 SW 23rd Dr., Gainesville, FL, 32608.*
[3]*Current address: University of Haifa, Oranim, Tivon, 36006 Israel.*

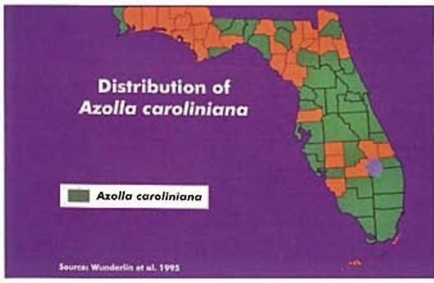

Figure 2. Distribution of mosquito fern, Azolla caroliniana, in Florida (Source Wunderlin and Hansen 1995, updated 2003).

The leaves of mosquito fern are small, bilobed and scalelike, and its stem is branched (**Figure 3**). Plants are green when young but turn red or brown as they age. Reproduction can occur through spores or vegetative propagation. Species of *Azolla* reproduce rapidly and under ideal conditions can increase their biomass daily by more than 15% (Hill 1999). At that rate, mosquito fern is capable of doubling its biomass in just 5 to 7 days.

Mosquito fern is considered an economically important species in some parts of the world, primarily Asia. It acts as a nitrogen fixer in small bodies of water in association with the blue-green alga *Anabaena azollae* Strasburger (Buckingham and Buckingham 1981), and is used as a fertilizer for rice fields in Vietnam and China (Sutton 1981). Mosquito fern also may be a good food source for grass carp production (Sutton and Vandiver 2000). However, when populations of mosquito fern increase to form large floating mats in Florida's waterways, the plants become a general nuisance by interfering with livestock watering, impeding navigation and fishing, and displaying an unsightly appearance. In the United States, mosquito fern is considered a weed because it has very little economic benefit (Sutton, 1981). This aquatic plant also may contribute to public health problems because disease-vectoring mosquitoes of the genus *Mansonia* are known to deposit their eggs on mosquito fern (Gerberg 1970).

Figure 3. Close-up view of individual plants of mosquito fern, Azolla caroliniana (Photo credit: K.L. Langeland).

Figure 4. Mating adults of the waterfern weevil, Stenopelmus rufinasus (Photo credit: USDA, ARS).

Natural Enemies of Mosquito Fern

Biological control involves the planned use of undomesticated organisms to manage weeds or other pests. In contrast, natural regulation (or natural control) occurs when one organism suppresses another organism without human intervention. At least three native insects are associated with the natural regulation of mosquito fern in Florida: the waterfern weevil [*Stenopelmus rufinasus* Gyllenhal (Coleoptera: Curculionidae: Curculioninae: Erirrhinini)], the waterfern flea beetle [*Pseudolampsis guttata* (LeConte) (Coleoptera: Chrysomelidae: Alticinae)], and the waterlettuce moth [*Samea multiplicalis* (Guenée) (Lepidoptera: Pyralidae)]. All three insects are highly destructive leaf feeders that complete their life cycles entirely on the plant. Under normal conditions, large populations of these insects can cause the rapid collapse of mosquito fern mats (Buckingham 1994).

The waterfern weevil (**Figure 4**) feeds and reproduces on the leaves, consuming several plants a day in the larval stage (Hill 1999). Adults are usually about 1.7 mm in length. The larvae are leaf miners and have three instars. After completing the larval stage, the mature larva spins a cocoon on the leaf surface in which to pupate. Allowing for variations in temperature, the entire life cycle is completed in 11 to 18 days (Richerson and Grigarick 1967). The waterfern weevil has four to six generations a year and overwinters as an adult.

The waterfern flea beetle (**Figure 5**) feeds extensively on the upper leaf lobes. Adults range from 2 to 2.5 mm in length and are strong jumpers. A single adult is capable of consuming an entire plant in approximately 1.5 to 2 days. Like the waterfern weevil, larvae of this flea beetle undergo three instars before pupating in a cocoon on the leaf surface. The entire life cycle, once again accounting for temperature variation, can last from 24 to 34 days (Center et al. 2002). Continuous generations occur in Florida.

Figure 5. Adult waterfern flea beetle, Pseudolampsis guttata (Photo credit: USDA, ARS).

The waterlettuce moth (**Figure 6**) feeds on mosquito fern and two other host plants in Florida: waterlettuce, *Pistia stratiotes* L. and water spangles, *Salvinia minima* Baker. The larval stage of the waterlettuce moth has five or six instars and the life


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Figure 6. Larva and feeding damage of waterlettuce moth, Samea multiplicalis (Photo credit: USDA, ARS).

cycle of this insect is completed in 23 to 28 days, depending on the temperature. The effect of this species on mosquito fern can vary depending on the season, as populations of the waterlettuce moth are not as persistent on the plant as are the two beetle species (Center et al. 2002).

The Red Imported Fire Ant

The red imported fire ant, *Solenopsis invicta* Buren (Hymenoptera: Formicidae; Myrmicinae) (**Figure 7**) was accidentally introduced to the Mobile, AL, area from Argentina or Brazil about 70 years ago (Hedges 1997). It now infests more than 320 million acres (128 million hectares) in Puerto Rico and 12 states from Florida to California (Williams et al. 2001, Core 2003). All 67 counties in Florida are infested with fire ants.

Worker fire ants commonly observed in the field are 5 to 7 mm long and red in color, as their name suggests. They are social insects, living in colonies of as many as 200,000 to 300,000 (Vinson 1997). Colonies can include multiple queens, winged males and females, workers, pupae, larvae and eggs. The life cycle from egg to adult, including the four-instar larval stage, takes 22 to 38 days to complete (Hedges 1997).

Figure 7. Red imported fire ant worker, Solenopsis invicta (Photo credit: J.L. Stimac).

Fire ants are omnivorous, feeding on plant and animal matter. Insects and other invertebrates make up a substantial portion of their food (Vinson 1997). Because of their feeding habits, fire ants have been considered beneficial in certain situations where they may help to control other pests. Under other circumstances, however, they can disrupt the process of natural regulation by reducing the abundance and diversity of beneficial arthropod herbivores, predators and parasitoids. This fact occasionally counteracts whatever status they may have garnered as "beneficial" (Vinson 1997).

Fire ants will build mounds in all types of soil habitats — including pastures, forests, roadsides, urban areas, cultivated crop fields and recreational areas — but they prefer moist soil conditions, and often build mounds on the edges of lakes and ponds, especially during dry periods.

Indirect Effects of the Red Imported Fire Ant on Mosquito Fern Populations

In the 1990s, a pond experiment was conducted at the UF/IFAS Center for Aquatic and Invasive Plants on biological control of the invasive aquatic weed hydrilla, *Hydrilla verticillata* (L.f.) Royle (Hydrocharitaceae). We did not anticipate having a problem with mosquito fern mats covering the experimental ponds because of the existence of the plant's natural enemies in Florida. Before long, however, mosquito fern completely covered the ponds, preventing the growth of the hydrilla by shading out this submersed weed. On more than one occasion, the mosquito fern mats had to be physically removed from the surface of the ponds but would return to a thick cover within a matter of days (see **Figure 1**). Upon closer examination, we observed fire ants actually foraging on the surface of the mosquito fern mats; they were removing caterpillars of the water-lettuce moth. At this point, we suspected that fire ants might be interfering with the process of natural regulation of the mosquito fern. A decision was made to control the fire ant mounds located in close proximity to three of the ponds with an experimental disease-causing fungus *Beauveria bassiana* (Balsamo) Vullemin (Deuteromycetes) that was being developed as a biopesticide after laboratory studies showed the fire ants were susceptible to infection by the fungus (**Figure 8**) (Stimac et al. 1993). *Beauveria bassiana* was presented to the foraging fire ants in paper bags containing the fungus formulated in a peanut butter bait (**Figure 9**).

Before the bait treatment, the dry weight biomass of mosquito fern averaged 95 grams per square meter of pond surface (n=2 samples per pond) (**Figure 10**). In addition, an average of 85 fire ants was collected in plastic vials baited with a small piece of hot dog randomly placed

Figure 8. Red imported fire ant, *Solenopsis invicta*, ***infected with the fungus*** *Beauveria bassiana* ***(Photo credit: J.L. Stimac).***

Figure 9. Paper bag bait station containing *Beauveria bassiana* ***formulated with peanut butter (Photo credit: J.L. Stimac).***

on the mosquito fern mats along the shoreline (n=4 samples per pond) (**Figures. 10 & 11**). Nine days after the *Beauveria* bait treatment, the number of fire ants declined dramatically to less than 10 per sample vial. Overall, a 79.4% reduction in fire ants was observed following the bait treatment, and the mosquito fern had completely disappeared from the surface of the ponds (**Figures 10 & 12**).

Conclusions

Fire ants are the dominant insect predators in disturbed terrestrial ecosystems and cause significant negative ecological effects on biodiversity (Wojcik et al. 2001). They are known to prey on all life stages of invertebrates, including the eggs. Recent studies have shown that arthropod species diversity declined by 30% and the number of non-fire ant individuals decreased by 75% at fire ant infested sites (Wojcik et al. 2001).

The presence of fire ant mounds in close proximity to ponds or lakes completely covered with mosquito fern for extended periods of time suggests that predation by foraging fire ants may be interfering with the process of natural regulation of this aquatic plant. Our observations have shown that in these situ-

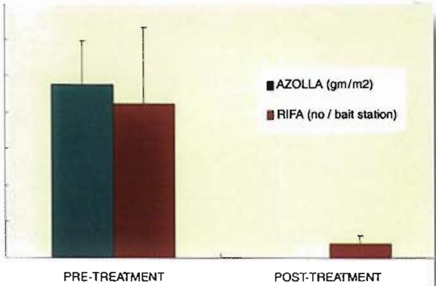

Figure 10. Dry weight biomass (gm/m^2) of mosquito fern, Azolla caroliniana, and the number of red imported fire ants (RIFA) caught per sample vial before and after the Beauveria bassiana bait treatment, Center for Aquatic and Invasive Plants, October-November, 1994. A zero value for the azolla biomass was recorded after the bait treatment.

Figure 11. Plastic vial baited with a piece of hot dog shown on the surface of a dense mosquito fern mat near the bank of one of the three sampling ponds. The vials were used to monitor fire ant populations during the course of the experiment (Photo credit: J.L. Stimac).

Figure 12. Research pond in Figure 1 shown 9 days after deployment of the fire ant bait containing the fungus Beauveria bassiana. The mosquito fern mat dropped out completely after the treatment.

ations, controlling fire ant mounds adjacent to ponds or small lakes with an approved treatment method (Collins and Scheffran 2001) may help to restore the ecological balance between the plant and its insect herbivores.

Recently, the USDA Agricultural Research Service funded and implemented a new biologically-based area wide management program to reverse the negative effects of fire ants on ecosystem functions such as the disruption of the natural regulation of waterfern by it native herbivores described here (Williams et al. 2003). This new program that includes an IPM approach integrating natural enemies of the fire ant with chemical insecticides may finally provide a permanent solution to the fire ant problem across entire landscapes in the southeastern United States (Williams et al. 2003). For more information about the area wide fire ant program, go to www.ars.usda.gov/fireant/.

Acknowledgements

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SePRO Corporation enters into Development and Supply Agreement with Dow AgroSciences

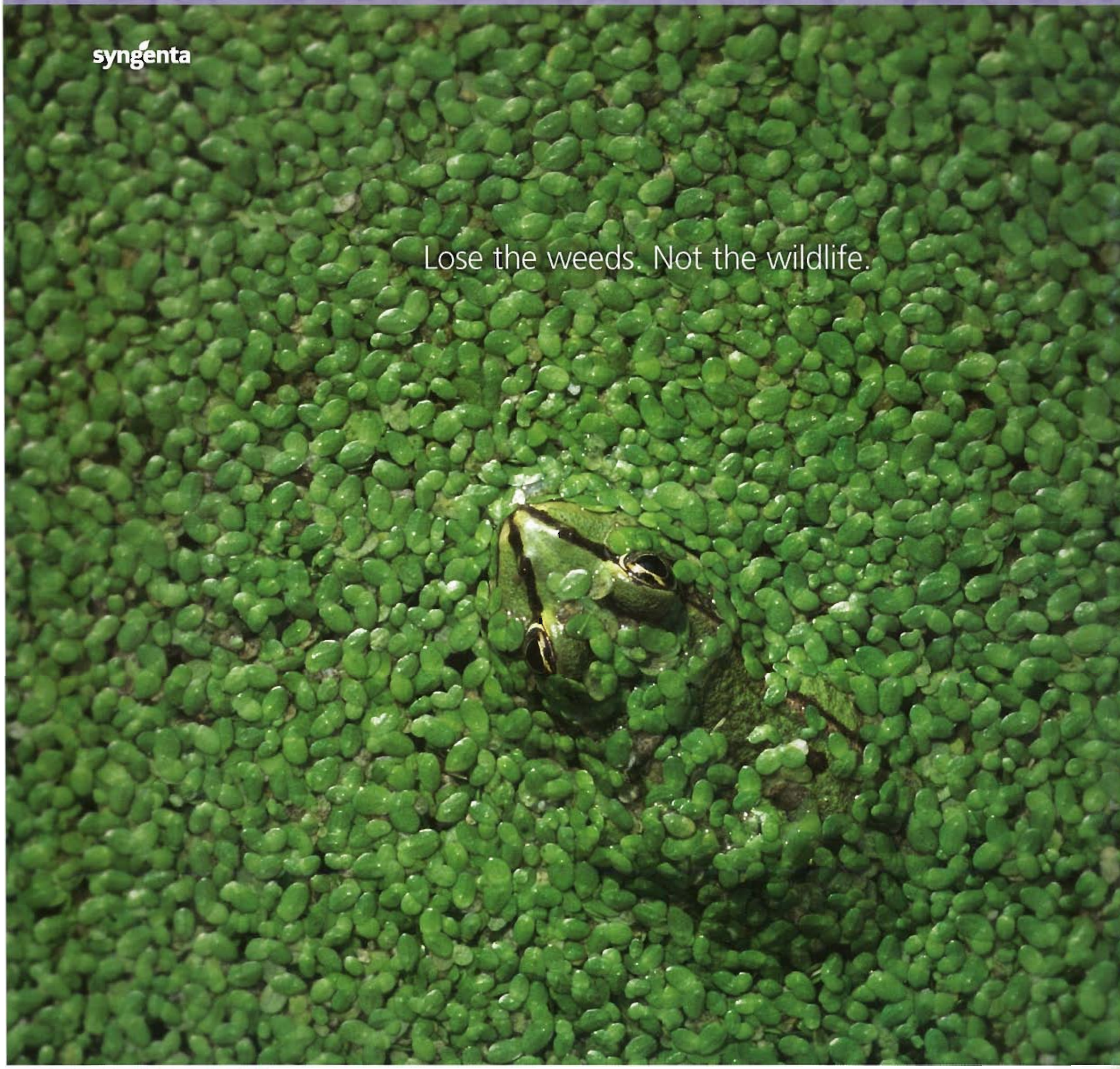
On May 5, 2004, Dow AgroSciences announced the signing of a development and supply agreement with SePRO Corporation of Carmel, Ind., for the development of a new herbicide for use in non-crop aquatic environments. SePRO has code named this new developmental product SP-1019. The product use patterns would include selective invasive weed control in lakes, reservoirs, ponds, irrigation canals, rivers, marshes and wetlands. SP-1019 will be fully characterized for the public at the upcoming National Aquatic Plant Management Society (APMS) meeting in July. The product is currently being tested under an Experimental Use Permit issued by the U.S. Environmental Protection Agency (EPA).

Changes at the Center for Aquatic and Invasive Plants

On March 22, 2004, Dr. Bill Haller assumed the position of Acting Director of the UF/IFAS Center for Aquatic and Invasive Plants. Dr. Randall Stocker, who was the Center's director, has taken on new responsibilities in the new UF School of Natural Resources and Environment and is also Acting Chair of the UF Department of Fisheries and Aquatic Sciences. Good luck to you both!

USDA Invasive Plant Research Laboratory(IPRL) online Reports

The US Department of Agriculture's Invasive Plant Research Laboratory(IPRL) in Fort Lauderdale, Florida is actively working on many projects to control invasive plants in the U.S. You are invited to read the reports on current activities at the IPRL. To view the report, follow the link below to the TAME Melaleuca project internet site. http://tame.ifas.ufl.edu/media/docs/IPRLOffshootsMay04.pdf



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