
Aquatic Invasives Workshop

Presented by the:

**Central Florida Cooperative Invasive Species Management Area (CISMA),
East Central Florida CISMA & Florida Forest Stewardship Program**

**May 13, 2016; 8:30 am – 2:30 pm ET
UF/IFAS Orange County Extension Office**

Many exotic plants are invasive weeds that form expanding populations on our landscape and waterways, making management a challenge. Some exotic animals have also become a problem for resource managers. The rapid and effective dispersal characteristics of these invaders make them extremely difficult to eliminate. This workshop will describe some of the more common and troublesome aquatic invasive exotic species in central Florida, current methods being used to manage them and opportunities to partner and get assistance.



Tentative Agenda:

- 8:30 am **Sign-in, meet & greet (finish refreshments before entering meeting room)**
 - 8:50 **Welcome & introduction**, Sherry Williams, Seminole County Natural Lands Program
 - 9:00 **Aquatic herbicides and application techniques**, Dr. Stephen Enloe, UF/IFAS Center for Aquatic and Invasive Plants
 - 9:50 **Mosquito biology and disease**, Ed Northey, Volusia County Mosquito Control
 - 10:15 **Algae**, Michael Shaner, SePRO
 - 10:40 **Networking break**
 - 11:00 **Ludwigia plant complex**, Kelli Gladding, SePRO
 - 11:25 **Introduced aquatic herpetofauna in Florida**, Dr. Steve Johnson, UF/IFAS Dept. of Wildlife Ecology and Conservation
 - 11:50 **Lunch**
 - 1:00 pm **Hands-on plant and animal ID round-robin**, all staff
 - 2:30 **Evaluation, CEUs, adjourn**
-
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Central Florida
Cooperative Invasive Species Management Area

East Central Florida
Cooperative Invasive Species Management Area



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Funding for this workshop is provided by the USDA Forest Service through the Florida Department of Agriculture and Consumer Services Florida Forest Service, the Florida Sustainable Forestry Initiative Implementation Committee, Applied Aquatic Management, Inc., Aquatic Vegetation Control, Inc., Dow Chemical, Earth Balance, Florida's Aquatic Preserves, Modica & Associates, Florida Aquatic Plant Management Society, and SePro.

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2016 CISMA Aquatic Invasives Workshop

8:30 am

Sign-in, refreshments

8:50 am

Welcome and Introduction

Speaker- Sherry Williams, Seminole County Natural Lands Program

9:00– 9:50 am

Aquatic Herbicides and Application Techniques

Herbicides are a tool used for aquatic weed control. Many aquatic applicators often wrestle with several issues including label interpretation, herbicide selection and tank mixes, and application techniques.

This presentation will be an interactive clicker talk to test audience knowledge on these key issues and provide answers to several common problems.

Speaker – Dr. Stephen Enloe, UF/IFAS Center for Aquatic and Invasive Plants

9:50– 10:15 am

Mosquito Biology and Disease

Zika Virus: Breaking the cycle of non-native arbovirus transmission using IPM/IMM strategies- Presentation will include history & discovery of the virus, epizootic outbreaks in its endemic range, it's transition into an anthropophilic cycle, migration from the eastern hemisphere to the west. Discussion of the individual strategies of Integrated Pest Management, specific to this species, and the challenges due to the ecology of these species. Presentation will end with future strategies, and other possible illnesses "on the horizon".

Speaker- Ed Northey, Volusia County Mosquito Control

10:15– 10:40 am

Algae

Nuisance and noxious algae infestations are on an apparent global increase and can impede numerous uses of an aquatic resource including: swimming, fishing, irrigation, aesthetics, etc. With increased awareness of risks and negative impacts associated with algae afflictions, a corollary need arises for effective and ecologically sound management approaches. The overall objectives of this presentation are 1) to describe common types of nuisance algae in freshwaters, 2) to discuss negative impacts associated with nuisance algae infestations, and 3) to provide information and examples regarding proactive and reactive management approaches.

Speaker – Michael Shaner, SePRO

10:40-11:00 am

Networking Break

11:00- 11:25 am

Ludwigia Plant Complex

Creeping water primrose, *Ludwigia grandiflora/ hexapetala*, has expanded significantly throughout the southeast. This macrophyte is still being distinguished by researchers but for operational management, the plant is considered a Category I invasive exotic species by the FLEPPC. Talk will discuss management of creeping water primrose, recent results of various aquatic herbicide trials, and affective application techniques.

Speaker- Kelli Gladding, SePRO

11:25- 11:50 am

Introduced Aquatic Herpetofauna in Florida

Presentation will focus on introduced, aquatic reptiles and amphibians. Covers an overview of introduced amphibians and reptiles in Florida, and how they impact management for aquatic and natural areas. Review of their natural history, identifying features, invasion pathway, and status in Florida. Last, management options for some species will also be discussed.

Speaker- Dr. Steve Johnson, UF/IFAS Dept. of Wildlife Ecology and Conservation

11:50 am- 1:00 pm

Lunch

1:00 pm- 1:30 pm

Early Detection and Rapid Response (EDRR) and less known species

This aquatic plant ID session will focus on EDRR species, as well as other lesser known aquatics and some typical aquatic invasive species. Live and pressed specimens are available for participants' observation of various species.

Speaker- Gloria Eby, Seminole County Watershed Management, Principal Environmental Scientist

1:30 pm- 2:00 pm

Exotic v. Native Look-alikes

Presentation covers identification of exotic aquatic invasive species compared to the Florida native species.

Speaker- Ed Harris, Florida FWC, Regional Biologist

2:00 pm-2:30 pm

Animals and Invertebrates ID

Presentation will cover proper ID of animals and invertebrates found in the aquatic ecosystem.

Speaker- Gary Warren, Florida FWC, Principal Scientist

Dr. Stephen Enloe, UF/IFAS Center for Aquatic and Invasive Plants

Dr. Enloe is an Associate Professor at the UF/IFAS Center for Aquatic and Invasive Plants. Dr. Enloe's research focus is terrestrial and aquatic invasive plant biology, ecology, and management. The Invasive Plant Extension program covers a number of very diverse audiences within the state, including State and Federal Agencies, commercial and private applicators, pond and land managers, and the general public.

Ed Northey, Volusia County Mosquito Control

Ed Northey is an Environmental Specialist II for Volusia County Mosquito Control. Ed is a Dodd Instructor and serves on committee for the Florida Mosquito Control Association (FMCA) and is on the Federal Lands Committee for the American Mosquito Control Association. Ed's most recent notable achievement was the awarding of the first state record of the Rock Pool Mosquito (*Aedes artopalmus*).

Michael Shaner, SePRO

Michael Shaner received his BS degree from East Carolina University in Cell and Anatomy along with his MS degree in Molecular Endocrinology. He is a Technical Specialist with SePRO Corporation here in Florida. He began his career with SePRO as the Laboratory and Research Group Manager in North Carolina. Prior to his appointment with SePRO, he was a Biology Instructor at Nash Community College and Teaching Assistant at East Carolina University. He currently serves on the Board of Directors for the South Florida Aquatic Plant Management Society.

Kelli Gladding, SePRO

Kelli Gladding graduated from Rollins College with her bachelor's degree in Environmental Science. Kelli is a representative with the SePRO Corporation and provides technical support to applicators and managers around the State of Florida. She has been the Co-Chair for the East Central Florida Cooperative Invasive Species Management Area (CISMA), currently serves on the Board of Directors for the Florida Aquatic Plant Management Society (FAPMS), and has worked for the Florida FWC Invasive Plant Management Section as a Regional Biologist focused on aquatics and managing the St. Johns River.

Dr. Steve Johnson, UF/IFAS Dept. of Wildlife Ecology and Conservation

Dr. Steve Johnson is a tenured faculty member in the Department of Wildlife Ecology and Conservation. Dr. Johnson's area of expertise is natural history and conservation of amphibians and reptiles, and he has worked extensively with imperiled species. He is a member of several professional societies, including the Society for Conservation Biology, Herpetologists League, and The Wildlife Society.

Gloria Eby, Seminole County Watershed Management, Principal Environmental Scientist

Gloria Eby is an aquatic biologist who received both her Bachelor and Masters Science degree in Biology from the University of Central Florida. She is a member of various scientific organizations/associations and was the first female president for the Florida Association of Benthologists. She has been with Seminole County's Watershed Management Division for 16 years and currently is a Principal Environmental Scientist.

Ed Harris, Florida FWC, Regional Biologist

Ed Harris is a regional biologist with the FloridaFWC Invasive Plant Management Section. He oversees the FWC programs in the upper Kissimmee basin and in Orange County and also represents FWC on several interagency task forces. He is a past president of the Florida Aquatic Plant Management Society.

Gary Warren, Florida FWC, Principal Scientist

Gary Warren is Principal Scientist and Project Leader of the Florida FWC Freshwater Invertebrate Research Unit. He has 29 years experience conducting research on invertebrate assemblages in Florida freshwater ecosystems. He has authored numerous peer-reviewed scientific papers and book chapters and most recently co-authored, *Freshwater Mussels of Florida* (University of Alabama Press).

Workshop Resource Contacts

<p>Jennifer Bernatis Biological Scientist II Florida Fish and Wildlife Conservation Commission (FWC) Research Institute (352) 415-6954 Jennifer.Bernatis@MyFwc.com</p>	<p>Kelli Gladding Market Development & Technical Support Specialist SePRO Corporation (386) 409-1175 kellig@sepro.com</p>	<p>Michael Shaner Aquatic Specialist SePRO Corporation (813) 415-1550 michaels@sepro.com</p>
<p>Kris Campbell Regional Biologist Florida FWC Invasive Plant Management Section (407) 858-6170 Ext. 223 Kristine.Campbell@MyFwc.com</p>	<p>C.J. Greene Invasive Plant Management Section Florida FWC (321) 246-0505 (mobile) Carl.Greene@MyFWC.com</p>	<p>Debi Stone Invasive Plant Program Supervisor Bureau of Land Resources St. Johns River Water Management District (386) 643-1921 dstone@sjrwmd.com</p>
<p>Chris Demers Extension Program Manager UF/IFAS School of Forest Resources and Conservation (352) 846-2375 cdemers@ufl.edu</p>	<p>Ed Harris Invasive Plant Management Section Florida FWC (407) 858-6170 Ed.Harris@MyFWC.com</p>	<p>Gary Warren Principal Scientist Freshwater Invertebrate Resource Assessment and Research Unit Florida FWC (352) 415-6965 Gary.Warren@MyFwc.com</p>
<p>Gloria Eby Principal Environmental Scientist Lake Management & Mosquito Control Programs Seminole County Watershed Management Division (407) 665-2439 GEby@seminolecountyfl.gov</p>	<p>Steven Johnson Associate Professor, PhD UF/IFAS Dept. of Wildlife Ecology and Conservation (352) 846-0557 tadpole@ufl.edu</p>	<p>Sherry Williams Natural Resources Program Coordinator Seminole County Natural Lands Program (407) 349-0551 Swilliams02@seminolecountyfl.gov</p>
<p>Stephen Enloe Associate Professor, PhD UF/IFAS Center for Aquatic and Invasive Plants (352) 392-6841 sfenloe@ufl.edu</p>	<p>Dennis Mudge Extension Agent UF/IFAS Orange County Extension (407) 254-9200 dmmudge@ufl.edu</p>	<p>Hannah Wooten Extension Agent UF/IFAS Seminole County Extension (407) 665-5554 hwooten@ufl.edu</p>
	<p>Edward Northey Environmental Specialist II Ops. Supervisor Dodd Instructor & committee, FMCA Federal Lands subcommittee, AMCA Volusia County Mosquito Control (386) 424-2920 enorthey@volusia.org</p>	

Got Invasives?

Invasive exotic plant problem? Find a program to help by using FloridaInvasives.org.

The Florida Invasive Species Partnership has collected, evaluated and categorized assistance programs into a single resource, making it easier to find the financial and/or technical assistance available to Florida landowners to prevent or control invasive exotic species problems. FloridaInvasives.org has an online resource of management assistance programs to help in your fight against problematic plant species. This resource takes the guesswork out of finding the agencies or organizations offering assistance and will direct you to available programs. The Landowner's Incentives Database will also provide the requirements for each program, to help you decide if they are a good match for your needs.

Why was FloridaInvasives.org developed?

Invasive species have been identified as being costly ecologically and economically statewide in Florida. The Florida Invasive Species Partnership (FISP) is a collaboration of public and private entities in Florida, formed to link efforts at preventing and controlling invasive exotic plants across agency and property boundaries. FISP has developed an on-line tool of available financial and technical assistance sources to make it easier for landowners and land managers to find them.

How does FloridaInvasives.org help you?

FISP has created a searchable database, the [Florida landowner incentives database](http://FloridaInvasives.org), accessible at FloridaInvasives.org that allows you to find an assistance program for your needs. Search by your county, target species or other pertinent information into the online tool, and you will retrieve a current list of available programs.

FloridaInvasives.org will help provide focus to your search so that you can get the right person at the right program.

FloridaInvasives.org:

- Builds community awareness,
- Leverages limited resources through cooperation and
- May reduce individual land management costs.

This resource will be regularly updated with the most current program information to provide you the most up-to-date opportunities.

Go to FloridaInvasives.org to find out more.

Species Shown from top to bottom:

Mexican Petunia, Boston Fern, Mimosa, Cogongrass, Camphor



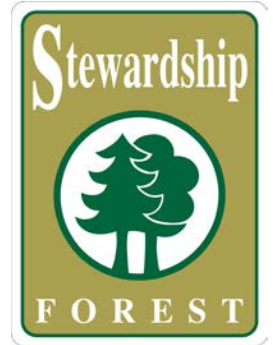
Think Locally, Act Neighborly

invasive species know no boundaries!



Florida's Forest Stewardship Program

Forest Stewardship is active management of forests and related resources to keep these lands in a productive and healthy condition for present and future generations, and to increase the economic, environmental and social benefits of these lands. Forest Stewards are landowners who manage their forestlands on a long-term basis by following a multiple resource management plan.



The Forest Stewardship Program addresses the improvement and maintenance of timber, wildlife, soil and water, recreation, aesthetics, as well as forage resources.

Eligibility

Private forest landowners with at least 20 acres of forest land and have a desire to manage their ownerships according to Stewardship principles can participate in the Forest Stewardship Program. Also, adjacent landowners, with similar management objectives, may combine their holdings to meet this acreage limitation.

Benefits to Landowners

- A customized management plan that is based on the landowner's objectives. The plan will include forest stand characteristics, property maps, management recommendations, and a five-year time line for future planning. This plan also serves as documentation of active management on the property that may help reduce tax liability.
- An opportunity for future public recognition as a certified "Forest Steward".
- Educational workshops, tours and a quarterly Stewardship newsletter developed and distributed by the University of Florida, IFAS Cooperative Extension Service.

Getting into the Program

Contact your local Florida Forest Service County Forester and tell them that you would like to have a Forest Stewardship Plan prepared for your property. More information and application here:

<http://www.freshfromflorida.com/Divisions-Offices/Florida-Forest-Service/For-Landowners/Programs/Forest-Stewardship-Program>



Tree Farm Program

The American Tree Farm System® is a program of the American Forest Foundation and was founded in 1941 to promote the sustainable management of forests through education and outreach to family forest landowners. Nearly 26 million acres of privately owned forestland and 80,000 family forest landowners in 46 states are enrolled in this program and committed to excellence in forest stewardship. About half of all Tree Farms are located in the South.

Eligibility

Private forest landowners with at least 10 acres of forest land and have a desire to manage their ownerships according to sustainable forestry guidelines can participate in Tree Farm.

Benefits to Landowners

Tree Farmers are good stewards of their forestland committed to protecting watersheds and wildlife habitat and conserving soil. They manage their forestland for various reasons, including timber production, wildlife, recreation, aesthetics, and education/outreach. Tree Farmers receive many benefits:

- Representation on local, state, and federal issues affecting forestland owners.
- Exposure to a network of forestry professionals and landowners committed to sustainable forestry.
- Access to seminars, field days, and workshops to help manage their Tree Farm even better.
- Certification that meets international standards of sustainable forest management.
- Participation in local, state, regional, and national Outstanding Tree Farmer of the Year awards and recognition.

Getting into the Program

Contact your local Florida Forest Service County Forester and tell them that you would like to join the Tree Farm program. More information here:

<https://www.treefarmssystem.org/florida>

WALKING THE LINE ON AQUATIC AND UPLAND HERBICIDE USE



STEPHEN F. ENLOE
CENTER FOR AQUATIC AND INVASIVE PLANTS



Directions for aquatic applications are generally clear...



The old cliché:
Always read the label!



...and so are label restrictions...

T&O irrigation restrictions

Glyphosate	No restriction
Hydrogen peroxide	No restriction
Carfentrazone (Stingray)	<20% surface acreage: no restriction 20-50% surface acreage: 14 days
Diquat (Reward)	2 gal/acre: 3 days 0.75-1.0 gal/acre: 2 days 0.50 gal/acre and spot spray: 1 day
Copper	No restriction
Endothall (Aquathol)	Liquid: 0.5 ppm – 7days; 3.0 - 14; >3 – 25 Granular: 7 days
2,4-D (Weedar 64)	7 days or <0.1 ppm
Triclopyr (Renovate)	120 days or <1.0 ppb
Imazapyr (Habitat)	120 days or <1.0 ppb
Fluridone (Sonar)	30 days or <10 ppb "FasTEST"

But what do you do
when the label is not
clear?



The same is true for here...

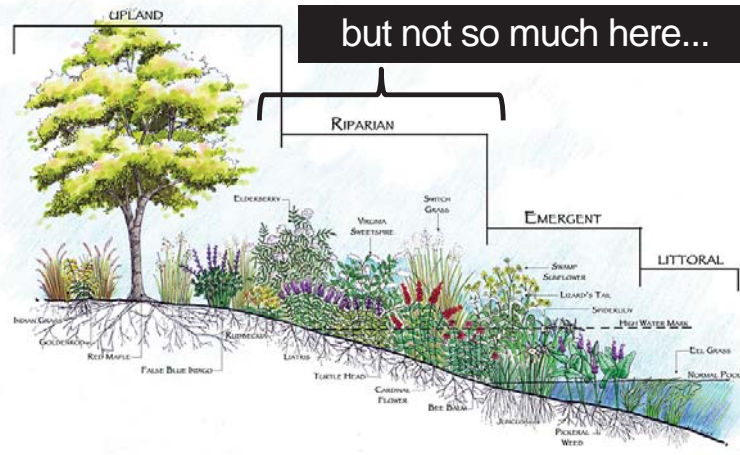


and here...

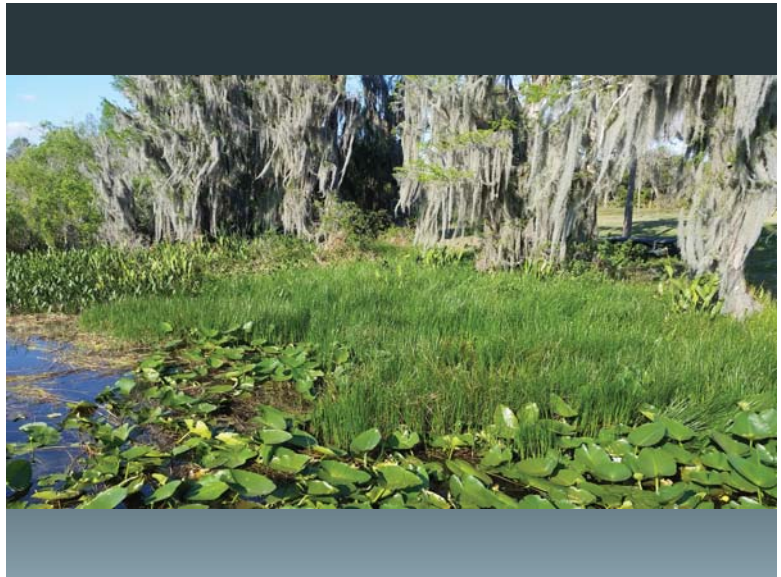


www.techlinenews.com

but not so much here...



http://www.clemson.edu/extension/hgic/water/resources_stormwater/shoreline_plants_in_south_carolina_waterfronts.html





www.Lakelandgov.net

So what do commonly used terrestrial and aquatic herbicide (labels) say about use along water?



Key Issues

- Toxicity to aquatic organisms
- Seasonal, ephemeral water in riparian areas
- Periodic standing water in upland and riparian areas
- Irrigation issues
- Swimming and drinking issues

Is water an issue? The Eye Test



- On the characterization of pornography by Supreme Court Justice Potter Stewart : "I know it when I see it" (Jacobellis v. Ohio, 1964).

Survey/Quiz Time!

Clicker Directions

- Completely anonymous
- Select the answer using the keypad
- You can change your answer by pressing a different button
- DO NOT TAKE MY CLICKERS!



Herbicide labels are:

- A. Easy to understand
- B. Fun to read
- C. Wildly entertaining
- D. Great bedtime reading
- E. None of the above



Floating and Marginal Weeds Including:

Water lettuce, *Pistia stratiotes*
Water hyacinth, *Eichhornia crassipes*
Duckweed, *Lemna* spp.
Salvinia spp. (including *S. molesta*)
Pennywort (*Hydrocotyle* spp.)
Frog's Bit¹, *Limnobium spongia*
Cattails, *Typha* spp.

Submersed Weeds Including:

Bladderwort, *Utricularia* spp.
Hydrilla, *Hydrilla verticillata*
Watermilfoils (including Eurasian), *Myriophyllum* spp.
Pondweeds¹, *Potamogeton* spp.
Coontail, *Ceratophyllum demersum*
Elodea, *Elodea* spp.
Brazilian Elodea, *Egeria densa*
Naiad, *Najas* spp.
Algae², *Spirogyra* spp. and *Pithophora* spp.

Any herbicide with this label statement cannot be used in water

Environmental Hazards

"This pesticide is toxic to aquatic invertebrates."

- A. True
- B. False



Labels are written according to use patterns, taking into account the environmental fate and toxicology



Environmental Hazards

This pesticide is toxic to aquatic invertebrates.

- A. True
- B. False

When making a terrestrial application, Reward can be applied directly to water as part of the application.



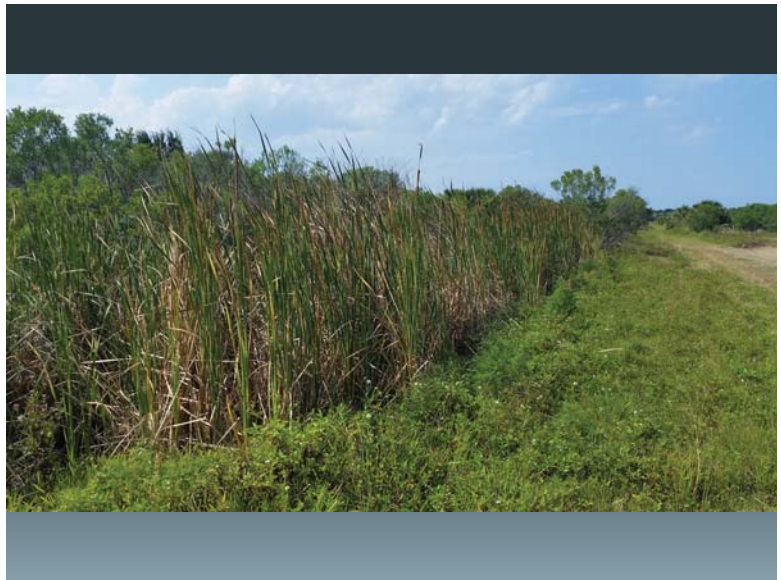
From the Reward Label:

Environmental Hazards

This pesticide is toxic to aquatic invertebrates.

For Terrestrial Uses, do not apply directly to water, or to areas where surface water is present, or to intertidal areas below the mean high water mark.

Do not contaminate water when disposing of equipment wash water. **For Aquatic Uses** do not apply directly to water except as specified on this label.



The presence of wetland indicator species prohibits the use of non-aquatic herbicides

- A. True
- B. False



DMA 4 VM

Herbicide
#Trademark of Dow AgroSciences LLC

For selective control of many broadleaf weeds in grass pastures, rangeland, Conservation Reserve acres, ornamental turfgrass (including turfgrass seed or seed), non-cropland and aquatic areas. A control of trees by injection.

Active ingredients:
2,4-Dichlorophenoxyacetic acid,
dimethylamine salt

Other ingredients:

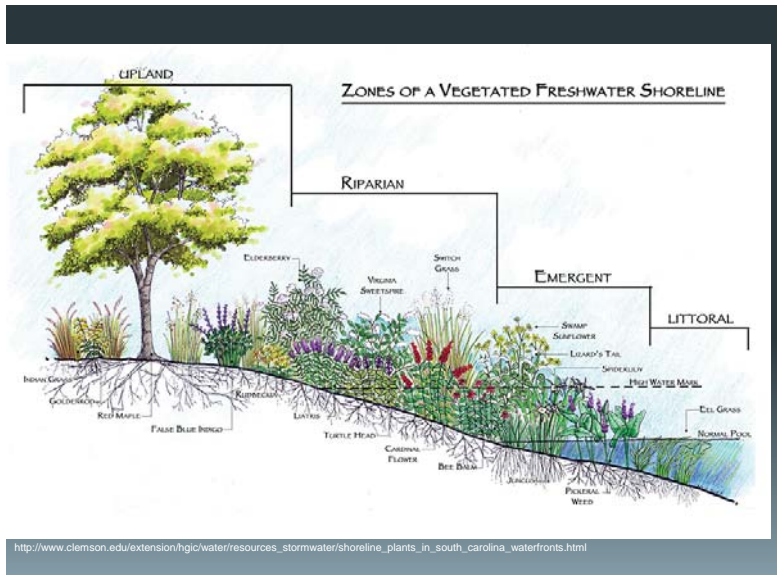
2,4-dichlorophenoxyacetic acid - 38.4% - 3.8 lb/gal

Environmental Hazards

This product is toxic to fish and aquatic invertebrates. For terrestrial uses: Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. Drift or runoff may adversely affect aquatic invertebrates and non-target plants. Drift and runoff may be hazardous to aquatic organisms in water adjacent to treated areas. Do not contaminate water when disposing of equipment washwaters or rinsate.

This chemical has properties and characteristics associated with chemicals detected in groundwater. The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination. Application around a cistern or well may result in contamination of drinking water or groundwater.

Aquatic Weed Control: Fish breathe dissolved oxygen in the water and decaying weeds also use oxygen. When treating continuous, dense weed masses, it may be appropriate to treat only part of the infestation at a time. For example, apply the product in lanes separated by untreated strips that can be treated after vegetation in treated lanes has disintegrated. During the growing season, weeds decompose in a 2 to 3 week period following treatment. Begin treatment along the shore and proceed outwards in bands to allow fish to move into untreated areas. Waters having limited and less dense weed infestations may not require partial treatments.





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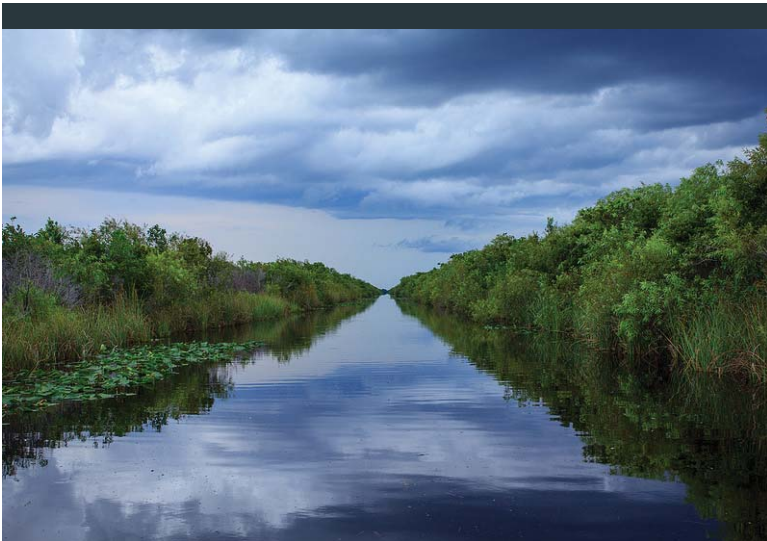
Wetland Sites in Forests and Non-Crop Areas

Garlon 3A may be used within forests and non-crop sites to control target vegetation in and around standing water sites, such as marshes, wetlands, and the banks of ponds and lakes and transition areas between upland and lowland sites.

For control of woody plants and broadleaf weeds in these sites, follow use directions and application methods on this label for forestry and non-cropland sites.

Use Precautions:

Minimize overspray to open water when treating target vegetation in and around non-flowing, quiescent or transient water. When making applications to control unwanted plants on banks or shorelines of flowing water, minimize overspray to open water. **Note:** Consult local public water control authorities before applying this product in and around public water. Permits may be required to treat such areas.



<http://www.dep.state.fl.us/water/wqssp/sf-canal.htm>



- A. True
- B. False

Garlon 3A applications cannot be made to woody brush along water if overspray into open water is unavoidable



- A. True
- B. False

In natural areas, Garlon 4 Ultra cannot be used on sites where any standing water is present



General Use Precautions and Restrictions

Chemigation: Do not apply this product through any type of irrigation system.

When applying this product in tank mix combination, follow all applicable use directions and precautions on each manufacturer's label.

Do not apply Garlon 4 Ultra directly to, or otherwise permit it to come into direct contact with cotton, grapes, peanuts, soybeans, tobacco, vegetable crops, flowers, citrus, or other desirable broadleaf plants. Do not permit spray mists containing it to drift onto such plants.

It is permissible to treat non-irrigation ditch banks, seasonally dry wetlands (such as flood plains, deltas, marshes, swamps, or bogs) and transitional areas between upland and lowland sites where surface water is not present except in isolated pockets due to uneven or unlevel conditions. Do not apply to open water (such as lakes, reservoirs, rivers, streams, creeks, salt water bays, or estuaries).

Do not apply on ditches that are used to transport irrigation water. Do not apply where runoff or irrigation water may flow onto agricultural land as injury to crops may result.

Do not apply this product using mist blowers unless a drift control additive, high viscosity inverting system, or equivalent is used to control spray drift.

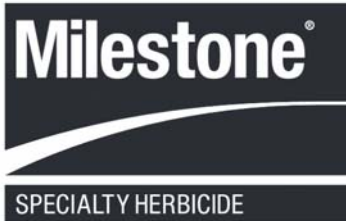
Sprays applied directly to Christmas trees may result in conifer injury. When treating unwanted vegetation in Christmas tree plantations, care should be taken to direct sprays away from conifers.

The actual intent of “isolated pockets due to uneven or unlevel conditions” refers only to situations such as tire track ruts.

- A. True
- B. False



This is not a pocket of standing water



®Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow

- For control of annual and perennial broadleaf weeds including invasive and noxious weeds, certain annual grasses, and certain woody plants and vines, on:
 - rangeland, permanent grass pastures (including grasses grown for hay¹), Conservation Reserve Program (CRP)
 - non-crop areas for example, airports, borrow ditches, communication transmission lines, electric power and utility rights-of-way, fencerows, gravel pits, industrial sites, military sites, mining and drilling areas, oil and gas pads, non-irrigation ditch banks, parking lots, petroleum tank farms, pipelines, roadsides, railroads, storage areas, dry storm water retention areas, substations, unimproved rough turf grasses; and
 - natural areas (open space) for example, campgrounds, parks, prairie management, trailheads and trails, recreation areas, wildlife openings, and wildlife habitat and management areas;
 - including grazed areas in and around these sites.

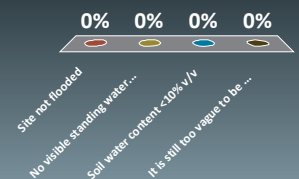
¹Hay from grass treated with Milestone within the preceding 18-months can only be used on the farm or ranch where the product is applied unless allowed by supplemental labeling

It is permissible to treat non-irrigation ditch banks, seasonally dry wetlands (such as flood plains, deltas, marshes, swamps, or bogs) and transitional areas between upland and lowland sites only when dry. Milestone can be used to the waters edge. Do not apply directly to water and take precautions to minimize overspray to open water when treating target vegetation in and around non-flowing, quiescent or transient water. When making applications to control unwanted plants on banks or shorelines of flowing water, minimize overspray to open water. Note: Consult local public water control authorities before applying this product in and around public water. Permits may be required to treat such areas.



The intent of “only when dry” is what?

- A. Site not flooded
- B. No visible standing water present
- C. Soil water content <math><10\%</math> v/v
- D. It is still too vague to be sure





itch banks, seasonally dry wetlands (such as flood plains, deltas, marshes, swamps) only when dry. Milestone can be used to the water's edge. Do not apply directly to open water when treating target vegetation in and around non-flowing, quiescent channels on banks or shorelines of flowing water, minimize overspray to open water. Note: product in and around public water. Permits may be required

What are some conclusions that we can draw from this?

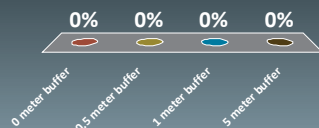


Conclusions

- The EPA has given applicators flexibility to make some judgement calls in riparian areas and seasonally dry wetlands
- You will (should) know it when you see it, regarding water as an issue.
- Document the absence of water when making applications in seasonally dry wetlands

What is the intent of “...can be used to the water’s edge”?

- A. 0 meter buffer
- B. 0.5 meter buffer
- C. 1 meter buffer
- D. 5 meter buffer



Conclusions

- Use diligence to keep ALL products out of the water when making terrestrial applications
- Better to be safe than sorry, don't be afraid to ask!
- Consult the company reps, IFAS, FDACS
- Submit label questions to Aquatics Magazine editor (Lyn Gettys) or me

Zika virus

TOOLS AND METHODS FOR BREAKING THE CYCLE OF ARBOVIRUS TRANSMISSION USING IPM/IMM STRATEGIES

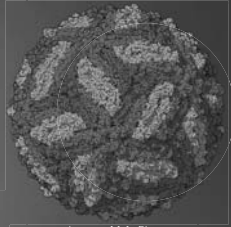


image: M.A. Rivas

Zika virus

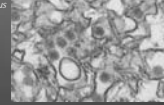
Mosquito and Vector Control operational strategies

- ▶ While the virus was isolated since its discovery during Yellow Fever research in 1952, its 1st noted outbreak was in 2007 – Yap Islands, Micronesia
- ▶ 2013: a pattern of arbovirus spreading from eastern to western hemispheres is noted = Dengue → Chikungunya → Zika; each with similar symptoms – fever, joint and muscle pain, headache, general malaise and skin rash. Requires PCR assay for confirmation.
- ▶ 2015: pandemic outbreak(s) occur in Brazil, Colombia, and El Salvador – *Aedes aegypti* (YF mosquito) is suspected and confirmed as the primary vector

Aedes aegypti



Zika virus



Zika virus

Mosquito and Vector Control operational strategies

- ▶ History and its ecology; virus and its vectors
- ▶ Control strategies
- ▶ Current & future issues



Photo courtesy of Google Images

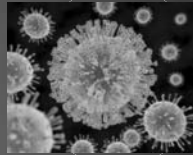


Photo courtesy of the CDC

Zika virus

Mosquito and Vector Control operational strategies

- ▶ Primary vector:
The Yellow Fever mosquito (*Aedes aegypti*)
Non-native; old world introduction (1700's)
- ▶ Secondary vector:
The Asian Tiger Mosquito (*Aedes albopictus*)
Non-native; new world introduction (1980's)



Photo courtesy of Google Images



© Sean McCann

Zika virus

Mosquito and Vector Control operational strategies

- ▶ Was 1st discovered in Uganda in 1947. (Fauci *et al*)
- ▶ Consider an isolated virus until recently; was held to the equatorial areas of Africa [Zika Forest], and S. E. Asia. The word, "Zika", means "overgrown" in its native language. (Connelly *et al*)
- ▶ Its primary cycle was Sylvatic; specifically wild primates as the reservoir and *Aedes africanus* as its primary amplifying arthropod.

Rhesus monkey

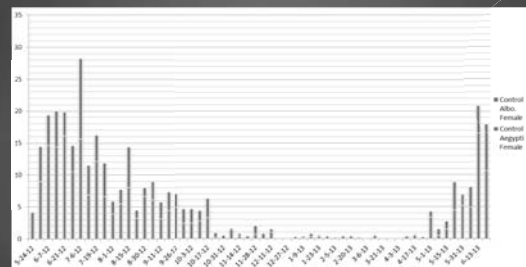


Aedes africanus



Zika virus

Mosquito and Vector Control operational strategies



Zika virus

Mosquito and Vector Control operational strategies

▶ Integrated Pest Management (IPM)/ Integrated Mosquito Management (IMM) strategies

1. Identify your target (pest)
2. Evaluate all options and treatment methods: chemical, biological, mechanical, and **(very important)** educational/cultural
3. Initiate multiple methods of control
4. Review and evaluate, both during & post operations

Zika virus

Mosquito and Vector Control operational strategies

- ▶ When ZIKA/DEN./CHIK is confirmed in a human (**local cohort** or **travel associated**), we must review epi-calendar for extrinsic[vector]/intrinsic[human] incubation periods
- ▶ 1st focus is **adult control**: reduction of virus in local cohorts
- ▶ 2nd, and just as important, **larval control**
- ▶ In addition, supplements of biological(s) applied where applicable and Public Education & Outreach measures performed.

Zika virus

Mosquito and Vector Control operational strategies

▶ Identify your target (pest) - know the cycles of transmission

For Zika/Dengue/Chikungunya: Human cycle [*Anthropophilia*]
Human - *Aedes aegypti*/*Ae. albopictus* - Human

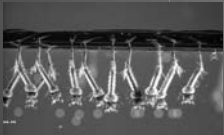


Photo: Google Images



Photo: UF/IFAS

Zika virus

Mosquito and Vector Control operational strategies

- ▶ 2 Key Periods
- ▶ **Intrinsic Incubation Period**- (human) From Time Bitten to "OnSet" (symptoms).
- ▶ **Extrinsic Incubation Period**- (mosquito) From Time Biting an Infective Human to being an *infective mosquito*. This timeframe is strongly influenced by temperature.

Zika virus

Mosquito and Vector Control operational strategies

▶ Evaluate all options and treatment methods

Issues with *Ae. aegypti* and *Ae. albopictus*:

Anthropophilic = wants to live in association w/ humans

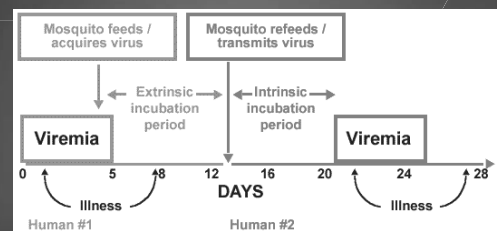
Diurnal feeding = challenges with adult control

Container production: found in artificial and natural containers

Cryptic production: found in less-than-obvious sites (CB's, cisterns, etc.)

Zika virus

Mosquito and Vector Control operational strategies



Breaking the cycle

▶ Adult control

Aerosolized adulticides: preference for dual action formulations (i.e. *Duet* and *benign agitation*).

Methods –

Hand foggers (P1, *Colt*, etc.)

Truck and UTV mounted U.L.V.

Residual contact sprays: (barrier spraying)



Breaking the cycle

▶ Truck mounted Micronair



Breaking the cycle

▶ Larval control

Application of residual Larvicide formulations are applied to containers/vessels holding water.....

Issues with this strategy:

Not all available containers are noted; either due to cryptic nature or refused entry on-site

Containers are portable/transient; residual formulation may not be appropriate, homeowners may remove items once inspected.



Breaking the cycle

▶ Then came the Buffalo.....



Breaking the cycle

▶ Larval control

Area-wide larviciding – applying larvicide, to the entire area, by aerosolizing the spray. This creates small droplets which travel through the air and deposit on containers; including cryptic or hard-to-reach containers



Breaking the cycle

▶ Advantages

Allows for robust penetration of solutions into all containers

Negates refused entry; applications are made from the ROW

Minimal personnel required to run the "buffalo" (driver and spotter)



Zika virus

Mosquito and Vector Control operational strategies

- ▶ Trial: Meeting of the Subcommittee On Managed Marshes (SOMM)

Placed 20 water-sensitive cards throughout the perimeter and under canopy of Building 5 – including cryptic areas: inside of containers, tire, and trashcans.

Buffalo turbine made one pass around the entire periphery of the structure

Spray was allowed to dissipate [winds greater than 15 mph], and cards reviewed by all in attendance...cards were later reviewed by *DropVision AG* for droplet confirmation [vouchering]

Acknowledgements

- ▶ Dr. Roxanne Connelly; UF/Florida Medical Entomology Lab.
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- ▶ Dr. Nathan Burkett-Cadena; UF/Florida Medical Entomology Lab.
- ▶ Florida Mosquito Control Association
- ▶ American Mosquito Control Association
- ▶ Dodd Plenary Course and fellow committee members, FMCA
- ▶ Leadership at County of Volusia Government
- ▶ All Statewide CISMA's

Thank You

Zika virus

Mosquito and Vector Control operational strategies

- ▶ Data from trial:

Temp: 88 F.

Wind: 20.7 mph

Wind direction: (from)140 degrees

Humidity: 60%

Avg Dv.1 = 267.83 micron

Avg Dv.5 (mean) = 569.11 micron

Avg Dv.9 = 953.01 micron

Avg NMD (median) = 192.48 micron

Avg Volume Density = 12.59 gal/ac



Work Cited

- ▶ By Manuel Almagro Rivas - Own work, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=47941048>
- ▶ Connelly et al; University of Florida, Florida Medical Entomology Laboratory. Print. University Print., 2015
- ▶ Selected images; Google Images. Web. 2015
- ▶ Selected images; Bing Images. Web. 2015
- ▶ Selected images; UF/IFAS. Web. 2015
- ▶ Selected images; UF/FMEL. Web. 2015

Zika virus

Mosquito and Vector Control operational strategies

- ▶ Future strategies

"LV" units for aerial application; would allow for larger treatment area (acreage) per mission...day or night

Skid - mounted Buffalo Turbine units; smaller unit than truck mounted

Use of ULV units as "LV" larvicide sprayers (current models in district use)

Thermal Foggers (old vs. new); helps to mitigate daytime issues with adulticiding

Questions?

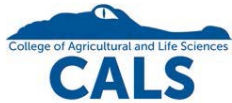


Introduced Aquatic Herpetofauna in Florida

2016 Central Florida CISMA Aquatics Workshop

Dr. Steve A. Johnson, tadpole@ufl.edu

Department of Wildlife Ecology and Conservation



Lecture Outline

- Definitions
- Florida's introduced herps
- Aquatic and semi-aquatic herps in FL
 - 3 frogs
 - 1 crocodylian
 - 3 turtles
 - 3 snakes
 - 3 lizards
- Distribution, invasion pathway, identification, ecology, impacts, management



Invasive Species

- **Invasives** are species, including their seeds, eggs, spores, or other biological material capable of propagating that species, that are not native to the ecosystem in which they are found (*human mediated movement implied*); and whose introduction *does or is likely to cause environmental or economic harm, or negatively impact human health or quality of life.*

National Invasive Species Council
<http://www.invasivespecies.gov/>

Executive Order 13112: "An alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health."



Introduced Herps in Florida

- Florida's Introduced Herpetofauna
 - 180 species documented
 - 63 species of established (breeding) amphibians and reptiles in Florida
 - 4 species of amphibians
 - 59 species of reptiles
 - Dominated by lizards, mainly geckos and anoles
 - Major invasion pathway is via the pet trade
 - Impacts include: ecological, economic, quality of life
 - Most species are poorly studied in Florida
 - Dominated by terrestrial species

Introduced Aquatic & Semi-aquatic Herps in Florida

- Amphibians—aquatic eggs and larvae
 - Cuban Treefrog
 - Cane Toad
 - African Clawed Frog
- Reptiles—primarily aquatic, semi-aquatic
 - Spectacled Caiman
 - Brown Basilisk
 - Nile Monitor
 - Green Iguana
 - Red-eared Slider
 - Southern Painted Turtle
 - False Map Turtle
 - Burmese & Rock Pythons
 - Javan File Snake



Cuban Treefrog

- *Osteopilus septentrionalis*—Cuban Treefrog
- Eggs and tadpoles aquatic; fishless wetlands, ornamental ponds, poorly maintained pools
- Native to Cuba, Bahamas, Cayman Islands
- Introduced to Florida in 1920s as hitchhiker on ornamental plants and cargo, also sold in pet trade
- Established throughout peninsula
- Panhandle records accumulating, showing up elsewhere in US



Cuban Treefrog

- Adult females to ~6 in., males to ~3.5 in.
- Variable colors and patterns
- Very diverse diet, eats native frogs
- Tadpole compete with some natives
- Invades urban & natural habitats
- Economic and quality of life impacts
- Selection for cold-hardy frogs?



African Clawed Frog

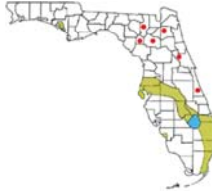
- *Xenopus laevis*—African Clawed Frog
- Fully aquatic in all life phases
- Native to Sub-Saharan Africa
- In Florida since 1970's
- Popular pet & aquatic "lab rat"
- Aquatic ornamental trade pathway?
- Only in one known location near Tampa in Gibsonton, aquatic fish farm?



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Cane Toad

- *Rhinella marina*—Cane Toad (*Bufo marinus*)
- Eggs and tadpoles aquatic; breed in small depressions, ditches, canals
- Native to Central/South America; So. Texas
- Introduced to Florida in 1930s as biological control, escapes from pet trade in 1950s is source of toads now
- Mainly in S & C FL, updated range map being developed



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Spectacled Caiman

- *Caiman crocodylus*—Spectacled caiman
- Aquatic crocodilian
- Inhabits ponds, lakes, canals in urban and agricultural areas
- Native to Central and northern South America
- Introduced via the pet trade, late 1950s
- Restricted dist. in Florida
 - Mainly Homestead, isolated records as far north as Seminole Co.



Cane Toad

- Adult females to ~7 in., males to ~6 in.
- Brown and warty, prominent paratoid glands
- Confined to urban & ag. areas in FL?
- Eats native inverts, vertebrates
- Toxic at all stages, threat to pets, annoying breeding choruses
- Major problems in Australia!!!



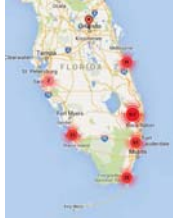
Spectacled Caiman

- Seldom over 6 ft. in FL
- Grey colored crocodilian with a curved ridge in front of its eyes
- Poorly studied in Florida, no obvious impacts known
 - Eat native fishes, birds, amphibians



Brown Basilisk

- *Basiliscus vittatus*—Brown Basilisk (aka JC Lizard)
- Semi-aquatic lizard
- Lives in close association with canal edges
 - Runs across or dives into water when threatened (especially juveniles)
- Native to Mexico, Central America to Colombia
- Introduced via the pet trade, mid 1970s
- Mainly in southern FL; Miami-Dade, Broward, St. Lucie, Collier Cos.



Nile Monitor

- Total length up to 6 ft.
- Grayish brown, bands of lighter spots on body
- Robust body, long neck, forked tongue
- Carnivorous diet—invasive sp., GTs, Burrowing Owl
- Nuisance to people, threat to pets, significant predator of native wildlife



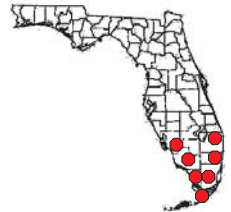
Brown Basilisk

- Total length usually < 2 ft., females < males
- Olive brown color, yellowish stripes, dark bands
- “JC” Lizard
- Long, thin legs and toes; long tail
- Males w/ prominent dorsal crest, less so in females
- Feed on insects
- Impacts negligible, unknown



Green Iguana

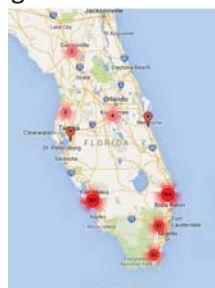
- *Iguana iguana*—Green Iguana
- Semi-aquatic lizard
- Lives in close association with water, good climbers
 - Dives into water when threatened, sleeps above water
- Native to Mexico, Central America, South America, Lesser Antilles
- Introduced via the pet trade, 1960s
- Confined to South Florida



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Nile Monitor

- *Varanus niloticus*—Nile monitor
- Semi-aquatic lizard
- Lives in close association with water, burrower
 - Dives into water when threatened, strong swimmer
- Native to sub-Saharan Africa
- Introduced via the pet trade, 1990
- Three major established pops in Florida



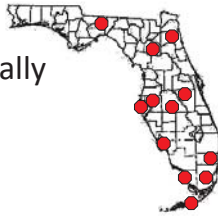
Green Iguana

- Total length up to 6 ft., females < males, (hatchlings, <10 in.)
- Juveniles green, adults brownish, dark bands on tail
- Robust body, prominent dorsal spines, large dewlap
- Herbivorous diet—eat ornamental plants
- Impacted by cold temps, drop from trees
- Nuisance to people, burrows undermine sea walls



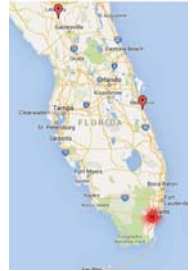
Red-eared Slider

- *Trachemys scripta elegans*—Red-eared Slider
- Aquatic turtle
- Lives in lakes and ponds, especially urban areas
- Native to eastern U.S., *T. s. scripta* in Florida
- Introduced via the pet trade, late 1950s
- Numerous pops in Florida
- Most widely introduced reptile globally



False Map Turtle

- *Graptemys pseudogeographic*—False Map Turtle
- Aquatic turtle
- Lives in lakes and ponds, especially urban areas
- Native to eastern U.S.
- Introduced via the pet trade
- Impacts unknown



Red-eared Slider

- Total shell length ~10 in.
- Greenish shell with light markings, red 'ear'
- Omnivorous diet
- Hybridizes with native slider, vector for *Salmonella*, displaces other basking turtles, ecology poorly known in FL
- Regulated by Florida law, none < 4 in. after 1 Jan 08



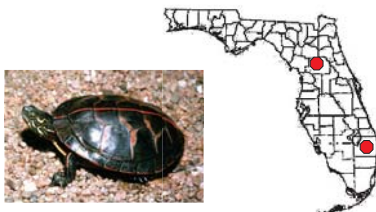
Javan File Snake

- *Acrochordus javanicus*—Javan File Snake
- Aquatic snake in monotypic family
- Inhabits aquatic environments exclusively
- Native to mainland SE Asia, Malaysia
- Introduced by animal importer in early 1970s
- Only one Florida pop. in a rock-mining pit in Miami-Dade Co.
- No confirmed records in last ~10 years
- Impacts, if any, unknown



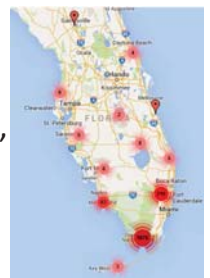
Southern Painted Turtle

- *Chrysemys dorsalis*—Southern Painted Turtle
- Aquatic turtle
- Lives in lakes and ponds, especially urban areas
- Native to eastern U.S.
- Introduced via the pet trade in 1960s, but may not have established
- Popular in pet trade
- Only breeding Florida pop @ FIU campus



Burmese Python

- *Python bivittatus*—Burmese Python
- Semi-aquatic constrictor snake
- Inhabits wetland and their associated 'dry patches'
 - Quite aquatic, seeks dry places to bask and nest
- Native to India & SE Asia
- Introduced via the pet trade, 1980s
- Established in Everglades and Naples, isolated reports elsewhere



Burmese Python

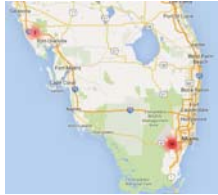
- Total length up to ~ 20 ft., 18 ft. is FL max
- Heavy body, patterned with giraffe-like markings of tan, brown, white
- Reach maturity in 3-4 yrs, CS to 100 eggs, lifespan of 15-25 yr
- Regulated by State and Federal laws (Lacey Act)
- **Significant predator** of native wildlife



Northern African Rock Python

- *Python sebae*—Rock Python
- Semi-aquatic constrictor snake
- Inhabits wetland and their associated 'dry patches'
 - Very aquatic, seeks dry places to bask and nest
- Native to Sub-Saharan Africa
- Introduced via the pet trade, 2000s
- Well established in Bird Drive Basin

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Efficacy of Herbicide Active Ingredients Against Aquatic Weeds¹

K. Langeland, M. Netherland, and W. Haller²

Only those herbicide products that are registered for application directly to water by the U.S. Environmental Protection Agency (EPA) and the Florida Department of Agriculture and Consumer Services (FDACS) may be used in Florida to control weeds growing in water. Active ingredients that are contained in aquatic herbicide products may also be present in products that are not approved for aquatic uses. However, it is not legal to apply an herbicide directly to water unless the herbicide label has specific instructions for application to water. Label instructions for aquatic use may restrict the use of water for a given period of time for various purposes, including, for some examples, irrigation and mixing agricultural sprays, domestic use, recreational use, watering livestock, or consuming fish from treated water.

It is legal to use a herbicide for attempting to control a plant species that is not listed on the label as long as the product is labeled for the site. A permit from the Florida Department of Environmental

Protection is required for control of weeds in public waters and waters with multiple ownership.

Table 1 is a quick reference to the effectiveness of herbicide active ingredients for controlling common aquatic weeds. Sensitivity of the target weed to the active ingredient is only one consideration in choosing the appropriate herbicide product. Other factors that may be important in such a decision include water uses, other plant species present, toxicity to fish and other organisms, and additives in individual products. These considerations, as well as other important aspects of aquatic weed control, are discussed more fully in other publications. *Aquatic Pest Control Applicator Training Manual* is available from the IFAS Extension Book Store (800/226-1764, <http://IFASbooks.ufl.edu>). Weed Control in Florida Ponds, EDIS Circular 707, is available at the following Web site: <http://edis.ifas.ufl.edu/AA238>.

Specific product information should be obtained by consulting the product labels; label instructions must be followed for any lawful herbicide application.

-
1. This document is SS-AGR-44, one of a series of the Agronomy Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original publication date, September 2006. Original authors included T. Koschnick, formerly a research assistant professor, Agronomy Department. This publication was revised in June 2009. Visit the EDIS Web site -- <http://edis.ifas.ufl.edu>.
2. Ken Langeland, professor, Agronomy Department, Center for Aquatic and Invasive Plants; Michael Netherland, courtesy associate professor, Center for Aquatic and Invasive Plants, and William Haller, professor, Agronomy Department, and acting program director, Center for Aquatic and Invasive Plants, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL.
- The use of trade names in this publication is solely for the purpose of providing specific information. UF/IFAS does not guarantee or warranty the products named, and references made in this publication to products does not signify UF/IFAS approval of the products to the exclusion of other products of suitable composition. Use all herbicides safely. Read and follow directions on the manufacturer's label.**

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Anyone who applies herbicides commercially or for a public agency should be licensed as a Restricted Use Pesticide (RUP) applicator. Information pertaining to RUP applicator training and licensing can be obtained from your County Cooperative Extension Service office. It is recommended that private pond owners employ a reputable aquatic-plant-management company to maintain their pond(s). Individuals who choose to apply herbicides to their own ponds should attain a basic understanding of herbicide application and ecology through RUP certification training. (For more on this topic, see EDIS publication PI26, *Licensing of Aquatic Herbicide Applicators in Florida*, <http://edis.ifas.ufl.edu/PI011>.)

Some herbicide active ingredients are available in only one or a limited number of products, which are registered for aquatic use. Other such active ingredients are available in many different products. Some of these products are identical while others may differ in additives that can affect the performance of the active ingredient. Representatives for herbicide manufacturers and distributors can provide information on different products. Additionally, FDACS, Division of Agricultural Environmental Services (850/847-2130) maintains a list with reference to the active ingredients of all pesticide products registered for use in Florida (<http://flpesticide.us>). Specimen product labels can be obtained from the Crop Data Management Systems, Inc (<http://www.cdms.net/manuf/manuf.asp>) or from manufacturer representatives or their Web sites.

Table 1. Effectiveness of Herbicide Active Ingredients for Aquatic Weed Control

	Endothal		Diquat	2,4-D		Copper ¹	Fluridone ²	Glyphosate	Imazapyr	Tri-clopyr	Carfentrazone	Penoxsulam ²	Imazamox	Hydrogen peroxide
	Aquathol	Hydrothol		Granular	Liquid									
FLOATING														
Duckweed	* ²	*	G	*	F	*	E	*	*	*	*	E	*	*
Watermeal	*	*	*	*	*	*	F	*	*	*	F	G	*	*
Water fern	*	*	E	*	*	*	E	*	*	*	E	E	*	*
Mosquito fern	*	*	E	*	*	*	E	*	*	*	E	E	*	*
Water hyacinth	*	*	E	*	E	F	*	G	E	E	F	E	E	*
Water lettuce	*	*	E	*	*	F	*	F	E	*	E	E	G	*
Frog's bit	*	*	E	*	*	*	*	*	E	F	*	E	E	*
Alligatorweed	*	*	*	*	F	*	*	G	E	G	*	F	E	*
SUBMERSED														
Bladderwort	F	F	G	F	*	*	G	*	*	*	*	F	*	*
Brazilian elodea	*	*	E	*	*	E	G	*	*	*	*	G	*	*
Coontail	E	E	E	G	*	*	E	*	*	F	*	*	*	*
Hydrilla	E	E	E	*	*	G	E	*	*	*	*	E	G	*
Parrotfeather	E	E	G	F	*	*	F	*	*	G	*	G	F	*
Pondweed	E	E	G	*	*	G	F ⁴	*	*	*	*	E ⁴	G	*
Slender naiad	E	E	E	*	*	G	E	*	*	*	*	F	*	*
Southern naiad	G	G	E	*	*	G	G	*	*	*	*	E	*	*
Proliferating spikerush	*	*	*	*	*	*	F	*	*	*	*	F	*	*
Variable leaf milfoil	G	G	G	E	*	*	G	*	*	E	*	G	G	*
EMERSED														
American lotus	*	*	*	G	*	*	*	G	G	E	*	*	E	*
Cattail	*	*	G	*	*	*	F	E	E	*	*	*	E	*
Fragrant waterlily	*	*	*	E	*	*	G	E	E	G	*	F	E	*
Soft rush	*	*	*	F	F	*	*	G	E	*	*	*	*	*
Spatterdock	*	*	*	E	F	*	G	E	E	F	*	F	E	*
Water pennywort	*	*	F	G	G	*	*	E	E	G	*	E	E	*
Torpedograss ⁴	*	*	*	*	*	*	*	E	E	*	*	*	*	*
ALGAE														
Macrophytic	*	F	F	*	*	F	*	*	*	*	*	*	*	*
Filamentous	*	G	G	*	*	G	*	*	*	*	*	*	*	*
Planktonic	*	*	*	*	*	G	*	*	*	*	*	*	*	G

¹ Copper can be applied with diquat at a rate of 2 lb metallic copper and 4lb diquat cation for difficult-to-control species, such as hydrilla.

² Submersed plants absorb fluridone and penoxsulam very slowly, and their efficacy is highly dependent on concentration and contact time.

³ * = Not recommended; G = Good; F = Fair; E = Excellent

⁴ Certain species, such as *Potamogeton illinoensis*, are relatively tolerant to fluridone while others, such as *P. nodosus*, are sensitive.

⁵ Re-growth occurs from underground plant parts and repeat applications are necessary.

A Note on Florida's Latest Waterprimrose,

Ludwigia hexapetala

by Colette Jacono, PhD

As the days lengthen and temperatures rise, the plant life around our lakes and rivers is starting to stir. Before our green friends shift into full spring throttle, now is a good time to survey shorelines and offshore zones for a growth form that could later spell trouble – trouble by the name of *Ludwigia hexapetala*, Uruguayan waterprimrose. This vigorous emergent is the most recent aquatic plant to be tagged a Category I invasive species by the Florida Exotic Pest Plant Council (FLEPPC 2013). While its luxuriant leaves and bright flowers attract more attention in summer, its rosette form may be the best indicator of what is in store for the season ahead.

Floating rosettes are the early growth form, and in mild climates, the winter resting form, for a number of the most aquatic of species within the generic group of plants called *Ludwigia*. A floating rosette is a dense, circular arrangement of radiating leaves clustered near the tip of a floating stem. Very early rosettes lie on the water surface, yet they soon rise to become more emergent than floating. Their leaves are nearly orbicular or spoon shaped, with the tips rounded and the edges quickly tapering to the base. The leaf edges are smooth and their upper surfaces shiny due to protective cells that repel water. As the season progresses, the stems emerge higher and higher from the water and the stems and foliage change in character which, along with successive flowers and fruit, lend to the ability to delineate individual species within *Ludwigia*. So while simply the presence of floating rosettes does not mean an invasion of *L. hexapetala*, it is a signal that note should be made of its location and percent coverage so that monitoring can be continued until characters develop for species identification.

When spring turns to summer, the stems of *L. hexapetala* often extend upright to a meter above the water. At the same time they will sprawl across and under the surface to form floating mats, yet consider this – the proportion of emergent material is small compared to the mass of buoyant stems and roots that have been developing underwater, and out of sight. In this manner, not only does *L. hexapetala* blanket open water and native plants, but it occludes the complex structure of the littoral zone that offers the best fish habitat. Not too sparse, yet not too dense, undisturbed communities of



Figure 1. Emergent rosettes of *Ludwigia hexapetala* abound on Lake Harney, Florida. Photo courtesy of Kelli Gladding, FWC.

Kissimmee grass, *Paspalidium geminatum*, provide excellent structure for supporting and distributing periphyton and epiphytic macroinvertebrates up through the water column, where they can be eaten by fish (in Florida: Schramm and Jirka, 1989; Welch 2009, and in Tanzania: Bailey et al., 1978; Bowker and Denny, 1978). Yet, with the encroachment of *L. hexapetala* into offshore zones of Kissimmee grass, as has happened in the Kissimmee Chain of Lakes (KCOL), fish habitat may also have been hit hard.

Through the height of the summer



Figure 2. Pollen bearing flowers of *Ludwigia hexapetala* on Lake Harney, Florida. Photo courtesy of Kelli Gladding, FWC.



Figure 3. Luxurious with flowers and nearly glabrous summer growth, *Ludwigia hexapetala* penetrates beds of pickerelweed and giant bulrush off the western shore of Lake Tohopekaliga, Florida. Photo courtesy of Keshav Setaram, SFWMD.

season, the emergent stems and leaves, now large and elliptic in shape, are succulent and glossy (nearly devoid of hairs) as flowering begins. Later in the season though, the stems become tough and reddish-brown, the leaves appear more lance-like or pointed in shape, and most importantly, plants put on hairs across the leaf and stem surfaces. From this point it is difficult to detail the subtle nuances between *L. hexapetala* and the closely related species, *L. grandiflora*, which has previously been recorded in Florida. Both bear clear yellow flowers that develop on short stalks directly off the stem. Distinction between the two becomes problematic when the measurements of their floral characters overlap or when leaf shape and degree of surface hairs vary because of the growth stage or changes in the aquatic environment. In the southeastern states, this is more often than not the case. Emphasis placed on character traits that are “more or less ...” holds little exactitude

as intermediate types seem to be more common than plants that are true to type in the southeast (Zardini et al, 1991; Nesom and Kartesz, 2000; author’s data). Also, seed capsules, an important character for identification, typically are not produced. Use of an entire population, rather than individual specimens, will often be needed, as well as chromosome karyotyping to help distinguish identity, which can be difficult even for experts.

The new *Ludwigia* in the KCOL and in central lakes of the St. Johns River drainage may seem familiar to those who have fished or traveled the large lakes of North and South Carolina’s coastal plain. Specimens from the Carolinas compare best with Florida material, indicating that region as the likely source. The question remains as to whether *L. hexapetala* is native to the southeastern US. Its earliest record dates back to 1844, from South Carolina, and 20 years later, to Georgia, but whether these records reflect the simple lack of early collection or a historical introduction is not clear. With certainty, *L. hexapetala* was introduced to France in the 1840s and later carried to Spain and Belgium. The ornamental trade carried *L. hexapetala*, as well as *L. grandiflora*, to the Pacific coast where regions of northern California, Oregon and Washington have been sorely affected.

AFLP analysis of Pacific coast populations demonstrates that the two species have remained genetically distinct in their rather newly introduced range, where clonal reproduction and spread predominates (Okada et al., 2009). Meanwhile, the prevailing theory in the southeastern US is that hybridization, or introgression between the two species, may explain the propensity of intermediate morphology displayed by so many specimens (Nesom and Kartesz, 2000; author’s data). Such speculation is not out of line since natural hybrids between *L. grandiflora* and *L. hexapetala* have been demonstrated (by chromosome number) at three independent sites in Brazil, a central region of native range.

What’s to come next with the *Ludwigia* saga in Florida? Herbicide warriors are already making good strides and even

mechanical harvesting has had an impact. High water levels have been effective in temporarily reducing biomass and sequestering flowering in the KCOL, yet occurrences at new locations continue and the resulting need for field recognition and identification remains. Flowering specimens, pressed and labeled, may be sent for identification to the Herbarium at the Florida Museum of Natural History, 379 Dickinson Hall, PO Box 110575, Gainesville, FL 32611-0575.

Author information: Dr. Colette Jacono (colettej@ufl.edu) is a Courtesy Assistant Research Scientist at the Florida Museum of Natural History in Gainesville, Florida.

References

- Bailey RG, S Churchfield, T Petr and R Pimm. 1978. The ecology of the fishes in Nyumba ya Mungu reservoir, Tanzania. *Biological Journal of the Linnaean Society* 10:109-137.
- Bowker, D.W. and P. Denny. 1978. The periphyton communities of Nyumba ya Mungu Reservoir, Tanzania. *Biological Journal of the Linnaean Society* 10(1):49-65.
- FLEPPC. 2013. List of Invasive Plant Species. Florida Exotic Pest Plant Council. Internet: <http://www.fleppc.org/list/list.htm>
- Nesom GL and JT Kartesz. 2000. Observations on the *Ludwigia uruguayensis* complex (Onagraceae) in the United States. *Castanea* 65(2):123-125.
- Okada M, BJ Grewell and M Jasieniuk. 2009. Clonal spread of invasive *Ludwigia hexapetala* and *L. grandiflora* in freshwater wetlands of California. *Aquatic Botany* 91:123-129.
- Schramm HL and KJ Jirka. 1989. Epiphytic macroinvertebrates as a food resource for bluegills in Florida lakes. *Trans. American Fisheries Soc.* 118:416-426.
- Welch ZC. 2009. Restoring pattern without process in lake restoration: A large-scale littoral habitat enhancement project on Lake Tohopekaliga, Florida. PhD Dissertation; University of Florida, Interdisciplinary Ecology, Gainesville, Florida; 133 p.
- Zardini EM, G Hongya and PH Raven. 1991. On the separation of two species within the *Ludwigia uruguayensis* complex (Onagraceae). *Systematic Botany* 16: 242-244.

Some Resources for Identifying and Controlling Invasive Exotic Plants



University of Florida/IFAS Center for Aquatic and Invasive Plants, <http://plants.ifas.ufl.edu/>

Florida Department of Agriculture and Consumer Services, Florida Forest Service, Invasive Non-native Plants, <http://www.freshfromflorida.com/Divisions-Offices/Florida-Forest-Service/Our-Forests/Forest-Health/Invasive-Non-Native-Plants>

Florida Exotic Pest Plant Council Invasive Plant Lists, <http://www.fleppc.org/list/list.htm>

Florida Fish and Wildlife Conservation Commission, Invasive Plant Management Section, <http://myfwc.com/wildlifehabitats/invasive-plants/>

Florida Natural Areas Inventory, Invasive Species, <http://www.fnai.org/invasivespecies.cfm>

United States Department of Agriculture, National Agricultural Library, National Invasive Species Information Center, Florida, <http://www.invasivespeciesinfo.gov/unitedstates/fl.shtml>

Miller, James H. 2003. **Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control.** U.S. Department of Agriculture, Forest Service, Southern Research Station, Asheville, N.C., Gen. Tech. Rep. SRS-62. 93pp.
http://www.srs.fs.usda.gov/pubs/gtr/gtr_srs062/ To request a printed copy, call 828-257-4830, or email pubrequest@fs.fed.us and ask for GTR-SRS-62.

Miller, James H., Erwin B. Chambliss and Nancy J. Loewenstein. 2010. **A Field Guide for the Identification of Invasive Plants in Southern Forests,** United States Department of Agriculture, Forest Service, Southern Research Station General Technical Report SRS-119. 126 pp.
<http://www.srs.fs.usda.gov/pubs/35292> Hardcopies available without charge from the Southern Research Station, 200 W.T. Weaver Blvd., Asheville, NC 28804.

Introduced and Invasive Species in Florida — Online Resources

Prepared by: Dr. Steve A. Johnson, Associate Professor, Dept. of Wildlife Ecology, University of Florida

Invasive Species Websites of General Interest

Florida Invasive Species Partnership—FISP: This website is an invaluable resource for land managers in Florida. An excellent resource provided by FISP is its “Florida Landowners Incentives Program”, which lists more than 25 potential sources of funds available to managers of private and public lands for control of invasive species. Other features of this site include an up-to-date calendar of events and news on invasive species, details for Florida’s Cooperative Invasive Species Management Areas (CISMAs), and information on reporting and mapping observations of invasive plants and animals. This is a MUST VISIT site for anyone responsible for managing Florida’s natural areas!

<http://www.floridainvasives.org/index.html>

The National Invasive Species Council—NISC: NISC is consortium of US federal agencies working together to address a myriad of invasive species nationally. NISC provides high-level interdepartmental coordination of federal invasive species actions and works with other federal and non-federal groups to address invasive species issues at the national level. Be sure to check out the 2008-2012 National Invasive Species Management Plan, which can be downloaded from NISC.

<http://www.invasivespecies.gov/index.html>

INVASIVES.ORG Center for Invasive Species and Ecosystem Health: The University of Georgia, in partnership with the USDA, hosts this great website and it’s worth a visit. There you will find links to species profiles and a diversity of reports and publications, a library of digital images, and much more. This site provides information on invasive plants, invertebrates, vertebrates, and diseases. Click the “Maps” button at the top of the home page to go to the EDDMapS where you can report observations of introduced animals and plants. You will want to bookmark this web page for sure.

<http://www.invasive.org/>

USDA National Invasive Species Information Center: This site is a “gateway to invasive species information; covering Federal, State, local, and international sources.” Although the information provided here for invasive vertebrates is relatively sparse, it is a great source of information for invasive insects, plants, and aquatic species. It also includes links to recent news and events on invasive species from a national perspective.

<http://www.invasivespeciesinfo.gov/index.shtml>

eXtension: “eXtension is an interactive learning environment delivering the best, most researched knowledge from the smartest land-grant university minds across America.” This site provides resources for a variety of species of North American wildlife, including invasive vertebrates such as feral hogs and armadillos. There is also a great deal of additional information potentially valuable to natural resource managers.

<http://www.extension.org/>

Florida Fish and Wildlife Conservation Commission—Nonnative Species: This site provides a general background on invasive species and the problems they cause, numerous links to invasive species resources, and rules and regulations governing non-native animals in Florida. This FWC site is especially valuable because it is the clearinghouse for information on the status of introduced animals in Florida. Here you will also find brief profiles for virtually all of the state's introduced animals.

<http://www.myfwc.com/nonnatives>

Species Profiles and Management Resources

eXtension

- Feral Hogs: http://www.extension.org/feral_hogs
- Armadillos: <http://www.extension.org/pages/8781/armadillo-damage-management#.Uo6eGulyga8>

Berryman Institute

- Feral Hogs: <http://www.berrymaninstitute.org/pdf/Managing%20Wild%20Pigs%205-2010.pdf>
- Coyotes: <http://www.berrymaninstitute.org/pdf/Mastro-coyote-addendum.pdf>

Internet Center for Wildlife Damage Management

- Armadillos: <http://icwdm.org/handbook/mammals/armadillos.asp>
- European Starlings: <http://icwdm.org/handbook/birds/EuropeanStarlings.asp>

Florida Fish & Wildlife Conservation Commission

- Armadillos: <http://myfwc.com/wildlifehabitats/profiles/mammals/land/armadillo/>
- Coyotes: <http://myfwc.com/wildlifehabitats/profiles/mammals/land/coyote/faqs/>
- Outdoor Cats: <http://myfwc.com/wildlifehabitats/nonnatives/mammals/feral-cats/>
- Feral Hogs: http://myfwc.com/media/2102702/6staffreport-wildhog_presentation.pdf
- Feral Hogs: <http://myfwc.com/wildlifehabitats/profiles/mammals/land/wild-hog/>
- Mallard/Mottled Ducks: <http://myfwc.com/wildlifehabitats/profiles/birds/waterfowl/mottled-ducks/>
- Mallard Ducks: <http://myfwc.com/license/wildlife/nuisance-wildlife/mallard-control/>

University of Florida Institute of Food and Agricultural Sciences

- Armadillos: <http://edis.ifas.ufl.edu/uw362>
- Coyotes: <https://edis.ifas.ufl.edu/uw397>
- Feral Hogs: <http://edis.ifas.ufl.edu/uw322>
- Iguanas: <http://edis.ifas.ufl.edu/in528>
- Purple Swamphen: <http://edis.ifas.ufl.edu/uw317>
- European Starling: <http://edis.ifas.ufl.edu/uw300>
- Cuban Treefrog: http://ufwildlife.ifas.ufl.edu/cuban_treefrog_inFL.shtml & <http://edis.ifas.ufl.edu/uw259>
- Cane (Bufo) Toad: <http://edis.ifas.ufl.edu/uw345>
- Burmese Python: <http://edis.ifas.ufl.edu/uw333> & <http://edis.ifas.ufl.edu/uw286>

Florida Museum of Natural History

- Iguanas: http://www.flmnh.ufl.edu/herpetology/kk/pdf/2007_Krysko_et_%20al-Iguana_iguana.pdf

University of Nebraska

- Outdoor Cats: <http://ianrpubs.unl.edu/live/ec1781/build/ec1781.pdf>

American Bird Conservancy

- Outdoor Cats: <http://www.abcbirds.org/abcprograms/policy/cats/index.html>

US Department of Agriculture

- Feral Hogs: http://www.aphis.usda.gov/wildlife_damage/feral_swine/
- Feral Hogs (Immunocontraception) :
http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1102&context=icwdm_usdanwrc
- European Starlings:
http://www.aphis.usda.gov/wildlife_damage/blackbirds_and_starlings/index.shtml

Cornell Lab of Ornithology

- European Starlings: <http://nestwatch.org/learn/nest-box-resource-center/managing-house-sparrows-and-european-starlings/>

Education and Training Resources

University of Florida Institute of Food and Agricultural Sciences

- UF Wildlife: This is a website with information about invasive vertebrates, their natural history, and management. Online guides to Florida's Snakes and Florida's Frogs & Toad can be found here too, as well as resources for educators. Be sure to check out the page for the *Invader Updater* (click the "Invasive Vertebrates" link), a quarterly newsletter focused primarily on providing information on invasive vertebrate animals in Florida and the southeastern US.
<http://ufwildlife.ifas.ufl.edu/>
- Reptile Early Detection and Documentation (REDDy): This is a free, online training module focused on identification and reporting of observations on large constrictors and carnivorous lizards in Florida. Numerous supplemental resources are provided.
<http://ufwildlife.ifas.ufl.edu/reddy.shtml>
- Buyers Guide to Pet Reptiles: This brochure offers advice on the purchase of pet reptiles. It is available as a tri-fold brochure at the second link below.
<http://edis.ifas.ufl.edu/uw357>
<http://ufwildlife.ifas.ufl.edu/pdfs/PARC%20pet%20buyers%20guide.pdf>
- Options for Unwanted Pets: This brochure offers advice on suitable options for unwanted exotic pets. A similar version is available as a tri-fold brochure at the second and third links below.
<http://edis.ifas.ufl.edu/uw353>
<http://edis.ifas.ufl.edu/pdffiles/UW/UW35300.pdf>
<http://ufwildlife.ifas.ufl.edu/pdfs/PARC%20Pet%20Brochure.pdf>

The Nature Conservancy

- Python Patrol: The Nature Conservancy conducts workshops that provide participants with hands-on training for safe and effective methods to capture large constrictors.
<http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/florida/howwework/s topping-a-burmese-python-invasion.xml>

Florida Fish and Wildlife Conservation Commission

- FWC Pet Amnesty Program: The FWC conducts several “Pet Amnesty” events each year throughout the state. Anyone is allowed to surrender unwanted, exotic pets (no dogs, cats, etc.) with no questions asked. After a veterinarian examines each animal, those deemed healthy are sent home with pre-approved, adoptive parents. FWC can also help place needy animals with adopters upon request.
<http://myfwc.com/wildlifehabitats/nonnatives/amnesty-day-events/>

National Park Service

- “Don’t Let It Loose”: This educational campaign provides numerous resources for educators on the issue of invasive species. The curriculum consists of numerous classroom activities targeted at middle school-aged students. “Interactive games and classroom activities instill students with the importance of responsible pet selection and ownership.”
<http://www.nps.gov/ever/forteachers/dlil.htm>

Aquatic Nuisance Species Task Force

- Habitattitude: This program is a partnership among several federal agencies—the USFWS is the lead—and the pet industry to educate the public about not releasing nonindigenous fish and aquatic plants.
<http://www.habitattitude.net/>

Center for Invasive Species and Ecosystem Health

- Early Detection & Distribution Mapping System—EDDMapS: Developed by the University of Georgia with support from several federal agencies, EDDMapS is the portal for reporting and mapping observations of nonindigenous animals and plants in Florida. Here you can report observations and check current distribution maps for introduced plants and animals. You can also download smartphone apps for reporting your observations.
<http://www.eddmaps.org/>

I hope you find these resources useful. If you have any suggestion, such as websites to add, please don’t hesitate to email me at tadpole.ufl.edu.

Aquatic Invasives Workshop

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