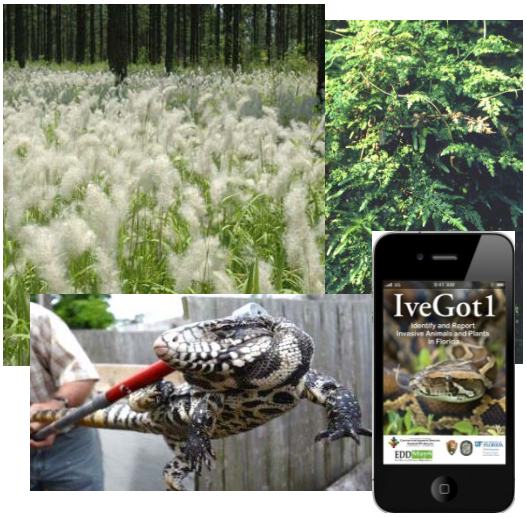
Florida's Forest Stewardship Program and Apalachicola Regional Stewardship Alliance CISMA

Present an

Invasive Exotic Species and Control Workshop

September 15, 2016; 9:00 am – 3:00 pm ET
Apalachicola National Estuarine Research Reserve
108 Island Drive, Eastpoint, FL 32328



Many exotic plants are invasive weeds that form expanding populations, making land management a challenge. Some exotic animals have also become a problem for land managers. The rapid and effective dispersal characteristics of these invaders make them extremely difficult to eliminate or manage. This program will describe some of the more common and troublesome invasive exotic plants and animals in this region and current strategies to control them.

Tentative Agenda:

9:00 am	**Sign-in, meet & greet**
9:15	**Welcome & introduction**, *Anita Grove, Apalachicola National Estuarine Reserve and Chris Demers, UF/IFAS School of Forest Resources and Conservation (SFRC)*
9:30	**Herbicide safety and application techniques**, *Pat Minogue, UF/IFAS SFRC*
10:30	**Break**
10:45	**Invasive exotic plant species ID and control techniques**, *Brian Pelc, The Nature Conservancy and Greg Jubinsky, Florida Natural Areas Inventory*
12:00 pm	**Lunch**
1:00	**Invasive exotic animals**, *Shelby Williams, Florida Fish and Wildlife Conservation Commission*
1:30	**The power of partnerships,** *Rose Godfrey, UF/IFAS SFRC and Brian Pelc*
2:00	**Break**
2:10	**Herbicide mixing demonstration**, *Pat Minogue and Richard Cristan, UF/IFAS*
3:00	**Evaluation, CEUs, CFEs, adjourn**

CEUs approved: 2.0 General Standards/Core 487, 2.0 General Standards Core 482, 3.0 Private Applicator, 2.0 Ag Row Crop, 3.0 Forestry, 3.0 Natural Areas Weed Mgmt, 3.0 ROW, 1.0 Limited Wildlife Trapper.
Fill out your contact information on your CEU form and the provider will sign it after the event.
SAF CFEs approved: 2.0 Cat 1 and 2.0 Cat 2. Make sure you have signed in on the CFE form.

Funding for this workshop is provided by the USDA Forest Service through the Florida Department of Agriculture and Consumer Services Florida Forest Service and the Florida Sustainable Forestry Initiative Implementation Committee.

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A big **THANKS** to our **Forest Stewardship Program Sponsors** on the back cover

Workshop Resource Contacts

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Forest Stewardship Program: http://www.sfrc.ufl.edu/forest_stewardship	**Apalachicola Regional Stewardship Alliance CISMA**: http://www.floridainvasives.org/Apalachicola/

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, 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

FISP
Florida Invasive Species Partnership

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://FreshFromFlorida.com/ForestStewardship

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.treefarmsystem.org/florida

Herbicide Safety and Application Techniques

Pat Minogue, Ph.D., R.F.
Associate Professor of Silviculture
School of Forest Resources and Conservation

SFRC

UF|IFAS
UNIVERSITY *of* FLORIDA

"I WANT A SPRAY THAT KILLS EVERYTHING BUT ISN'T DANGEROUS"

Pesticide Toxicity

Toxicity - measure of the potential to injure, kill, or cause an adverse effect for a particular organism

- **Acute - short term studies with the active ingredient AND product formulation required by US EPA for pesticide registration**
- **Chronic – studies of long term exposure, 12 & 24 month feeding studies with the active ingredient**

Exposure - contact with chemical

Hazard = Toxicity + Exposure

US EPA Acute Toxicity Studies:

- Acute oral
- Acute dermal
- Acute inhalation
- Primary eye irritation
- Primary skin irritation
- Dermal sensitization

- LD_{50} Lethal dose to 50% of test species, mg/kg
- Used to determine "Signal Word" and "Personal Protective Equipment" (PPE)

Chronic Mammalian Toxicity

- Long term feeding studies, 12 and 24 month

- Carcinogenicity- Potential to cause cancer
- Potential for adverse effects on reproduction
- Teratogenicity- Potential to cause birth defects
- Mutagenicity- Potential to cause genetic changes

- Wildlife/Insect Toxicity- quail, duck, rainbow trout, bluegill, honey bee, *Daphnia* (water flea)

Toxicity and Persistence

PPM (parts per million):
1 inch in 16 miles
1 minute in two years
1 oz in 62,500 lbs
1 tbs in 3,906 gal
1 cent in $10,000
PPB (parts per billion):
1000 times less than ppm - 1 tablespoon in 3,906,000 gal

Half-life: Time for 1/2 of initial amount to be degraded

Parts per Million (ppm)

1 mg / kg = 1 ppm
1 liter of water = 1 kg
1 mg / liter = 1 ppm
1% = 10,000 ppm

Signal Word & Toxicity Categories

Acute Study	Category I DANGER	Category II WARNING	Category III CAUTION	Category IV (CAUTION)
Acute Oral	50 mg/kg	50-500 mg/kg	500-5,000 mg/kg	>5,000 mg/kg
Acute Dermal	200 mg/kg	200-2,000 mg/kg	2,000 – 5,000 mg/kg	>5,000 mg/kg
Acute Inhalation	0.05 mg/L	0.05-0.5 mg/L	0.5-2 mg/L	>2 mg/L
Primary Eye Irritation	Corrosive or corneal involvement more than 21 days	Corneal involvement or irritation clearing in 8-21 days	Corneal involvement or irritation clearing in 7 days or less	Minimal effects clearing in less than 24 hours
Primary Skin Sensitization	Corrosive	Severe irritation at 72 hours	Moderate irritation at 72 hours	Mild or slight irritation at 72 hours

The most severe toxicity type determines the category.

Restricted Use Pesticide

Due to acute toxicity. For retail sale to and use only by certified applicators or persons under their direct supervision and only for those uses covered by the certified applicator's certification.

PARAQUAT CONCENTRATE

Defoliant and desiccant herbicide for the control of weeds and grasses and as a harvest aid.

NEVER PUT INTO FOOD, DRINK OR OTHER CONTAINERS.
IF SWALLOWED, TAKE IMMEDIATE ACTION AS PRESCRIBED IN FIRST AID.
SYMPTOMS ARE PROLONGED AND PAINFUL.
DO NOT USE OR STORE IN OR AROUND THE HOME.
DO NOT REMOVE CONTENTS EXCEPT FOR IMMEDIATE USE.
THE ODOR OF THIS PRODUCT IS FROM THE STENCHING AGENT WHICH HAS BEEN ADDED, NOT FROM PARAQUAT.

Active Ingredient:
Paraquat dichloride (1,1'-dimethyl-4,4'-bipyridinium dichloride) 43.2%
Other Ingredients: 56.8%
Total: 100.0%

This product contains the toxic ingredient methanol at 7%.
Contains 3.0 pounds paraquat cation per gallon as 4.14 pounds of dichloride salt per gallon. Contains emetic and stench (odor).

KEEP OUT OF REACH OF CHILDREN

DANGER/PELIGRO

POISON

Acute oral toxicity of 50 mg/kg or less must have "POISON" and "Skull and Crossbones"

Specimen Label

Dow AgroSciences

Forestry Garlon® XRT

Specialty Herbicide

®Trademark of Dow AgroSciences LLC

For the control of woody plants and annual and perennial broadleaf weeds in forests and in the establishment and maintenance of wildlife openings. Use on these sites may include application to grazed areas.

Active Ingredient:
triclopyr: 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester 83.9%
Other Ingredients 16.1%
Total 100.0%

Acid equivalent: triclopyr – 60.3% - 6.3 lb/gal

EPA Reg. No. 62719-553

Keep Out of Reach of Children

WARNING AVISO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

Precautionary Statements

Hazards to Humans and Domestic Animals

Causes Substantial But Temporary Eye Injury • Harmful If Swallowed • Prolonged Or Frequently Repeated Skin Contact May Cause Allergic Reactions In Some Individuals

Do not get in eyes or on clothing. Avoid contact with skin. Wear protective eyewear. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, or using tobacco. Remove and wash contaminated clothing before reuse.

Personal Protective Equipment (PPE)

Applicators and other handlers who handle this pesticide must wear:

- Long-sleeved shirt and long pants
- Shoes plus socks
- Chemical-resistant gloves such as nitrile or butyl
- Protective eyewear

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

Engineering Controls

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS (40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS.

User Safety Recommendations

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

First Aid

If in eyes: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.
If swallowed: Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person.
If on skin or clothing: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-992-5994 for emergency medical treatment information.

Environmental Hazards

This pesticide is toxic to fish. 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 washwater 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.

MATERIAL SAFETY DATA SHEET

Dow AgroSciences

Emergency Phone: 800-992-5994
Dow AgroSciences LLC
Indianapolis, IN 46268

Effective Date: 13-Feb-07
Product Code: 106732

FORESTRY GARLON* XRT HERBICIDE

1. PRODUCT AND COMPANY IDENTIFICATION:

PRODUCT: Forestry Garlon* XRT Herbicide

COMPANY IDENTIFICATION:
Dow AgroSciences LLC
9330 Zionsville Road
Indianapolis, IN 46268-1189

2. HAZARDOUS IDENTIFICATIONS:

EMERGENCY OVERVIEW
Amber liquid with a mild odor. May cause eye and skin irritation. Toxic to aquatic organisms and birds.

EMERGENCY PHONE NUMBER: 800-992-5994

3. COMPOSITION/INFORMATION ON INGREDIENTS:

COMPONENT	CAS NUMBER	W/W%
Triclopyr-butyl	064700-56-7	83.9
Balance		16.1

4. FIRST AID:

EYE: Hold eyes open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, and then continue rinsing eyes. Call a poison control center or doctor for treatment advice.

SKIN: Take off contaminated clothing. Wash skin with soap and plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice. Wash clothing before reuse. Shoes and other leather items which cannot be decontaminated should be disposed of properly.

INGESTION: Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by the poison control center or doctor. Never give anything by mouth to an unconscious person.

INHALATION: Move person to fresh air. If person is not breathing, call an emergency responder or ambulance, and then give artificial respiration; if by mouth to mouth use rescuer protection (pocket mask etc). Call a poison control center or doctor for treatment advice.

NOTE TO PHYSICIAN: No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient. Have the MSDS, and if available, the product container or label with you when calling a poison control center or doctor, or going for treatment.

5. FIRE FIGHTING MEASURES:

FLASH POINT: >200°F (>93.3°C)
METHOD USED: Not applicable

FLAMMABLE LIMITS
LFL: Not determined
UFL: Not determined

EXTINGUISHING MEDIA: Foam, CO_2, or Dry chemical

FIRE AND EXPLOSION HAZARDS: Foam fire extinguishing system is preferred because uncontrolled water can spread possible contamination. Toxic irritating gases may be formed under fire conditions.

FIRE-FIGHTING EQUIPMENT: Use positive-pressure, self-contained breathing apparatus and full protective equipment.

6. ACCIDENTAL RELEASE MEASURES:

ACTION TO TAKE FOR SPILLS: Absorb small spills with materials such as sand, sawdust, Zorball, or dirt. Wash exposed body areas thoroughly after handling. Report large spills to Dow AgroSciences at 800-992-5994.

7. HANDLING AND STORAGE:

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Keep out of reach of children. Do not swallow. Avoid contact with eyes, skin, and clothing. Avoid breathing vapors and spray mist. Handle concentrate in ventilated area. Wash thoroughly with soap and water after handling and before eating, chewing gum, using tobacco, using the toilet or smoking. Keep away from food, feedstuffs, and water supplies. Store in original container in a well-ventilated area.

Diluted solutions are less toxic

- Undiluted Accord XRT II is 100 times more toxic than a 1% solution of Accord XRT II in water.
- Always take greatest precaution when handling undiluted products or concentrated solids.

Primary Routes of Exposure

- Oral
- Dermal
- Inhalation

Wash spray clothes separately!

Silvicultural Herbicide BMPs

- Follow Silviculture BMPs: (FL Forest Service)
  - Choose equipment that directs the chemical only to the target area.
  - Do not conduct aerial application, mist blowing, or operational application of pesticides within the Primary Zone (within 35 ft lakes, sinkholes to 200 ft Class I drinking water sources) of the Special Management Zone (SMZ)
  - Do not leave pesticide containers on site.
  - Do not rinse spray equipment or discharge rinse water in water bodies, wetlands, or within the SMZ.

Environmental Safety!!!

- Read "Environmental Hazards" and follow "Environmental Precautions" on product label.
- **Know your herbicide characteristics**, in particular:
  - Water solubility- potential to leach or move in surface flow
  - Soil sorption, mobility, half-life
  - Volatility

Application Methods

- **Hand-held Techniques**
  - Backpack Foliar
  - Basal Stem
  - Hack & Squirt
  - Cut Stump
  - Soil Spot and Soil Basal
- **Ground Sprayer Machinery**
- **Aerial Application**
- **Sprayer Calibration**

Backpack Foliar Sprays

- Best for **targeted** applications on low brush, **less than 4 feet tall**
- **Less than 1,500 rootstocks per acre**
- **Use low volumes**, **10-20** gallons spray per acre (GPA)
- **Common Herbicides:**
  - Arsenal® AC, Chopper®
  - Garlon® 4, Garlon® 3A
  - Accord® XRT

Proper Personal Protective Equipment

Basal Stem Treatment

- Spray bark of **small diameter stems**, < 4"d
- May be applied in **dormant season**
- Apply from **ground to 12-15** inches high
- Use with "**basal oil**" or oil emulsion carrier
- **Common Herbicides**
  - Garlon® 4 Ultra
    - No residual effect
  - Chopper® Gen II
    - Residual soil activity

Hack & Squirt (Cut Stem)

- Used on **taller vegetation**, greater than 4" **diameter**
- Make cuts at a **downward angle** around the tree
- See labels regarding solution concentration, spacing between "hacks".
- Generally apply 1 ml/hack, about the same as 1 pull on a squirt bottle.
- **Common Herbicides:**
  - **Arsenal® AC**
  - **Garlon® 3A**
  - **Weedar® 64 (2,4-D)**

Cut Stump

- Best for a **few targeted** trees
- Spray just the **cambium**
- Best on **freshly cut** stumps
- Treat all the stumps!
- **Common Herbicides**
  - **Chopper®, Stalker®**
  - **Garlon® 4 Ultra (ester), Garlon® 3A (amine)**
  - **Pathfinder® II (RTU)**
  - **Accord® XRT II**

Soil Basal and Spot Treatments

Spring applications

- Undiluted ***Velpar® L***
- Exact delivery handgun application to the **base of woody vegetation**
- For ***trees*** use 2-4 ml product **per inch** of stem diameter at breast height.
- For **brush** apply 2-4 ml product **per 3 feet** canopy width.

Ground Sprayer Design

Boom-less sprayers

- **Cluster nozzles**
- **Boom-Busters**
- **Flooding fan nozzles**

Jim Miller, TX

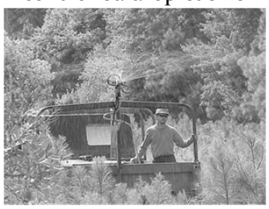
Boom Jet®

Ground Sprayer Design

Straight-stream manifold

Radiarc®

- controlled droplet size



Tractor Mounted Band Sprayer

- **Selective herbicides** over the top of planted trees
  - Oust® XP
  - Arsenal® AC
  - Velpar® L
  - Escort® XP
- A 4 to 6 foot wide band is common for herbaceous weed control on planted rows.
- Bands use **less herbicide** and have less environmental impact than broadcast treatment.

Aerial Herbicide Spraying

Rotor-wing aircraft

- Appropriate for **large areas** (40+ Acres), or difficult access.
- Herbicide plus burning has largely replaced mechanical forest site preparation.
- Selective herbicides can be applied **through the canopy mid-rotation**.
- Broadcast Velpar® or Oust® applications may **promote native grasses**.

Solids: Iso-Lair Bucket

Aerial Application of Solids

- **Modified seeders and fertilizer spreaders** are used to broadcast herbicide granules
- More difficult to control rate per acre and uniformity across the swath than sprays
- **Carrier evaporation is not a concern**
- **Fines or dust** in product formulations **increase potential for off-site movement**
- To avoid streaks or drift, do not apply when winds are gusty or exceed 5 mph

Fixed Wing Application

Helicopter Spraying

Rotor Vs. Fixed Wing

HELICOPTER
- Remote landing
- **Maneuverable**
- Slow air speed
- Used in sensitive areas

FIXED WING
- Greater payload
- Lower costs
- More potential for off-site movement
- **Not permitted** with some herbicides

Factors Affecting Drift Potential

- **Application parameters**, especially **droplet size** and spraying technique (nozzle selection, booms, aircraft, etc.)
- **Weather effects**, especially **wind speed and direction**, height of **inversion layer**
- **Tank mix effects**, product formulations, surfactants, emulsifiers, drift control agents

Small Droplets Give Good Coverage on the Leaf Surface

Droplet Diameter (Microns)	Droplets on Leaf (Per Sq. Inch)
50	92,250
100	11,750
200	1,425
400	180
800	22

Akesson and Yates, 1987, WSSA

Small Droplets Drift!!!!

Droplet Diameter (Microns)	Wind 1 mph	5 mph	10 mph
10	1.5 miles	7.5 miles	14.5 miles
100	75 feet	375 feet	750 feet
300	8 feet	42 feet	83 feet
600	2 feet	11 feet	21 feet
800	1 foot	6 feet	12 feet

Hansen, 1965; see Akesson and Yates, 1987, WSSA

Evaporation Rate & Droplet Size

20 ft, 1 mph Wind, 25C, 55%RH

Droplet Diameter (Microns)	Droplet Disappears (Fall Distance)
200	--
150	15 ft
120	7 ft
100	3.5 ft
80	2 ft

Akesson and Yates, 1987, WSSA

Application Parameters Effecting Droplet Size Spectrum

- **Orifice size** and type of nozzle
- Nozzle discharge angle
- **Pressure** at the nozzle
- **Application height**
- Droplet shear, turbulence, airspeed
- Evaporative losses while airborne

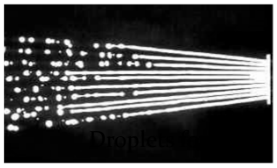
Aerial Spray Equipment

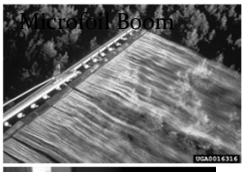
CONVENTIONAL
- Simplex(R) Boom
- Warnell(R) Boom
- Teejet(R) Disc-Core Nozzles
- Raindrop(R) Nozzles

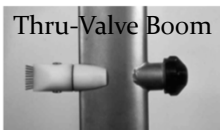
CONTROLLED DROPLET BOOMS
- Microfoil(R) Boom
- Thru-Valve(R) Boom
- Microfoil(R) Nozzles
- TVB(R) Nozzles
- Accu-Flo(R) Nozzles

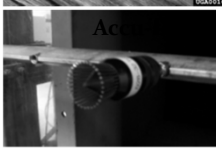
Advances in Aerial Application Technology

Controlled droplet size = reduced drift









GPS: Global Positioning Systems

- Documents **path of the aircraft**
- **Delineates** treatment area
- Very useful to **determine airspeed** ensure correct calibration of spray volume and herbicide rates per acre.
- Can be **integrated with injection systems** to control delivery rate.

Principles of Calibration

- Two ways recommendations are made:
  - A **percent solution basis**- "Apply a 2% solution of Accord as a directed spray to weeds and avoid any contact to longleaf seedlings."
    - Used for **spot treatments to individual plants** or where the vegetation area is variable or difficult to ascertain (patchy).
  - A **rate per acre basis**- "Apply 2.0 pounds active ingredient per acre as a broadcast foliar spray."
    - Used for broadcast treatments especially where **selective herbicides are being applied over tolerant crop trees or desired vegetation** and the dosage received must be carefully controlled.

Active ingredient vs. acid equivalent

- Salt = Acid + Base
- The label says "Accord® XRT contains 50.2% dimethylamine salt of glyphosate"
- "Accord contains 5.4 lb per gallon glyphosate dimethylamine salt (4.0 lb per gallon glyphosate acid)"
- i.e., there are 4 lb acid equivalent per gallon (ae/gal) and 5.4 lb active ingredient per gallon (ai/gal)

How to determine your rate per acre

- Just figure out **how many gallons per acre** you are spraying at a given:

1. Ground speed
2. Swath width
3. Spray output rate

There are only two things you need to know:
- How long does it take to treat 1 acre?
- How much solution do we use in the time it takes to treat 1 acre?

Example Calibration

- Four 8004 flat fan nozzles on 18 inch centers produce a six foot wide swath. The regulator is set at 25 psi and is producing 0.5 gallons/min spray output (all 4 nozzles).
- Pat is walking at 2.96 mph and has a metronome to keep his pace constant.
- **How long does it take to treat one acre?**

43560 sq ft/Ac divided by 6 foot swath = 7,260 ft to treat one acre.

3 mph = 15,840 ft per hour (60 min.)

<u>15,840 ft</u> is to <u>7,260 ft</u>

60 min. Z min.?

(15,840 ft X Z min.?) = (7,260 ft X 60 min);

Z min.? = 27.5 min.

Example calibration

- Ok, so we will take 27.5 minutes to treat an acre. Our boom is applying 0.5 gallons per minute.
- **How many gallons per acre are we applying?**
  - 27.5 min./acre X 0.5 gallons per minute = **13.75 gal/acre**

- If we want to apply 2 oz Oust® product per acre, how many oz Oust® should we add to the 27.5 gallons of water in our tank?

(hint: 13.75 X 2 = 27.5)

UF | IFAS
UNIVERSITY *of* FLORIDA

Patrick J. Minogue, Ph.D., R.F.
Associate Professor of Silviculture
North Florida Research and Education Center
Quincy, FL

SFRC

"New" EDRR Definition

A plant that is within your CISMA boundary, but limited in range and density (i.e., likely to be eradicable within your boundary) AND possesses a potential /probable threat to native species or communities within your CISMA.*

**Dependent on the range within your CISMA, for larger CISMAs a species could limited to certain areas (e.g. counties) of the CISMA and not in another*

APALACHICOLA REGIONAL STEWARDSHIP ALLIANCE CISMA EDRR Species

Ardisia japonica	Japanese ardisia	http://www.fnai.org/Invasives/Ardisia_japonica_FNAI.pdf
Broussonetia papyrifera	paper mulberry	Not available
Casuarina equisetifolia	Australian-pine	http://www.fnai.org/Invasives/Casuarina_spp_FNAI.pdf
Eichhornia azurea	anchored waterhyacinth	http://www.fnai.org/Invasives/Eichhornia_azurea_FNAI.pdf
Elaeagnus angustifolia	Russian olive	http://www.fnai.org/Invasives/Elaeagnus_angustifolia_FNAI.pdf
Elaeagnus umbellata	autumn olive	http://www.fnai.org/Invasives/Elaeagnus_umbellata_FNAI.pdf
Ipomoea aquatica	swamp morningglory	http://www.fnai.org/Invasives/Ipomoea_aquatica_FNAI.pdf
Iris pseudacorus	yellow iris	http://www.fnai.org/Invasives/Iris_pseudacorus_FNAI.pdf
Melinis repens	natalgrass	http://www.fnai.org/Invasives/Melinis_repens_FNAI.pdf
Microstegium vimineum	Japanese stilt grass	Not available
Myriophyllum spicatum	Eurasian water milfoil	http://www.fnai.org/Invasives/Myriophyllum_spicatum_FNAI.pdf
Paederia foetida	skunk-vine	http://www.fnai.org/Invasives/Paederia_foetida_FNAI.pdf
Panicum maximum	guinea grass	http://www.fnai.org/Invasives/Panicum_maximum_FNAI.pdf
Perilla frutescens	perilla mint	Not available
Rosa multiflora	multiflora rose	http://www.fnai.org/Invasives/Rosa_multiflora_FNAI.pdf
Rottboellia cochinchinensis	itch grass	Not available
Salvinia molesta	giant salvinia	http://www.fnai.org/Invasives/Salvinia_molesta_FNAI.pdf
Schinus terebinthifolius	Brazilian peppertree	http://www.fnai.org/Invasives/Schinus_terebinthifolius_FNAI.pdf
Solanum viarum	tropical soda apple	http://www.fnai.org/Invasives/Solanum_viarum_FNAI.pdf
Vitex rotundifolia	beach vitex	http://www.fnai.org/Invasives/Vitex_rotundifolia_FNAI.pdf

Updated on 4/05/2016 by GBW

Scientific Name Common Name Hyperlink

Ardisia japonica

JAPANESE ARDISIA

Origin: Japan
Florida Introduction Date: specimen vouchered in 1975

- Low running shrub
- Leaves with serrated margins, rough texture
- Flower small, 5-petaled, pink or white
- Fruit a red berry

Habitat: upland hardwood forests

- Only one record, possibly can prevent establishment.
- Spreads by suckers.

Casuarina spp.

AUSTRALIAN PINE

Origin: Australia
Florida Introduction Date: late 1800's

- Evergreen tree to 46 m
- Leaves reduced to small scales at nodes
- Flowers unisexual
- Woody cone-like fruiting heads

Habitat: coastal uplands, pine rocklands, disturbed sites

- Casuarina isn't often identified to species, but the genus is established in south and central zones.

Eichhornia azurea

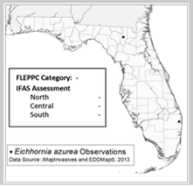
ROOTED WATER-HYACINTH

Origin: Central and South America
Florida Introduction Date: introduced in US in 1800's, unknown when introduced in Florida

- Perennial aquatic herb
- Leaves alternate, emersed leaves stalked (not inflated)
- Flowers showy, purple
- Rooted in the substrate

Habitat: coastal rivers and lakes

- Only vouchered from Columbia Co, but is a Federal Noxious Weed.
- Good to prevent establishment.



Elaeagnus angustifolia

RUSSIAN OLIVE

Origin: Southern Europe and western Asia
Florida Introduction Date: Introduced in US late 1800's; not established in Florida

- Large deciduous shrub or small tree to 25 m
- Leaves alternate, silver-gray, lance-shaped
- Flowers yellow, fragrant
- Fruit, hard, olive-like

Habitat: riparian areas

- Established nationwide but not yet vouchered in FL.
- Could be climate limited but would be good to keep out of state.
- Fixes nitrogen.

Elaeagnus umbellata

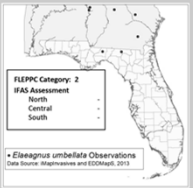
AUTUMN OLIVE

Origin: China and Japan
Florida Introduction Date: Introduced in US 1830, earliest voucher in Florida 1958

- Deciduous, busy shrub with thorny branches
- Leaves alternate, short-stalked, elliptic
- Flowers small, fragrant, white, tubular
- Fruit a showy red berry

Habitat: forest openings and open forests

- Widely established in natural areas in Georgia and to north.
- Seeds dispersed by mammals and birds.



Ipomoea aquatica

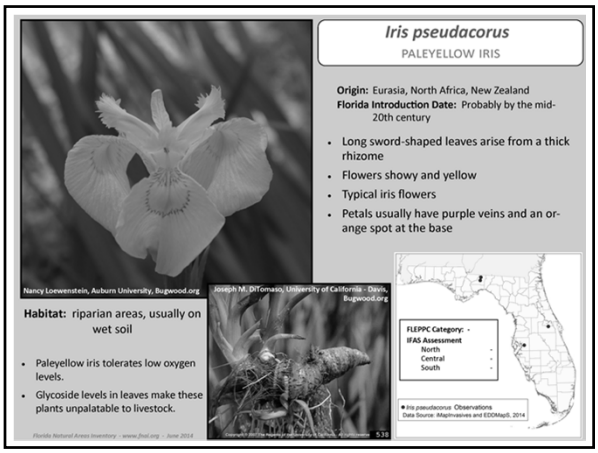
WATER-SPINACH

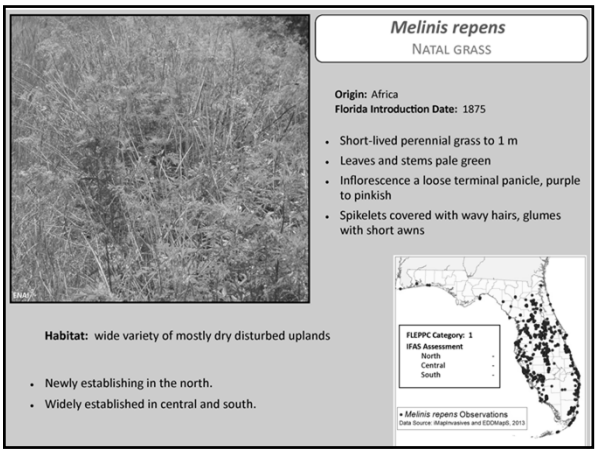
Origin: Central to south China
Florida Introduction Date: pre-1950

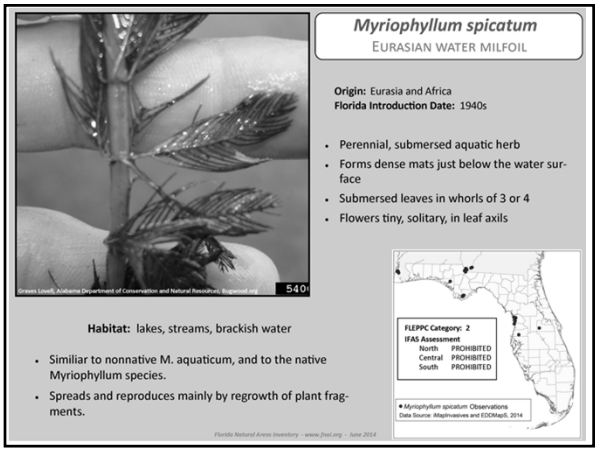
- Herbaceous aquatic vine
- Leaves alternate, stalked, arrowhead shaped
- Flowers showy, tubular, white
- Fruit an oval woody capsule

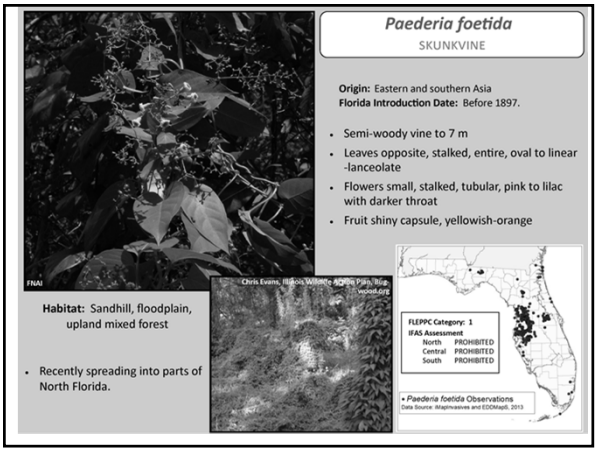
Habitat: shallow water in ponds, lakes and rivers

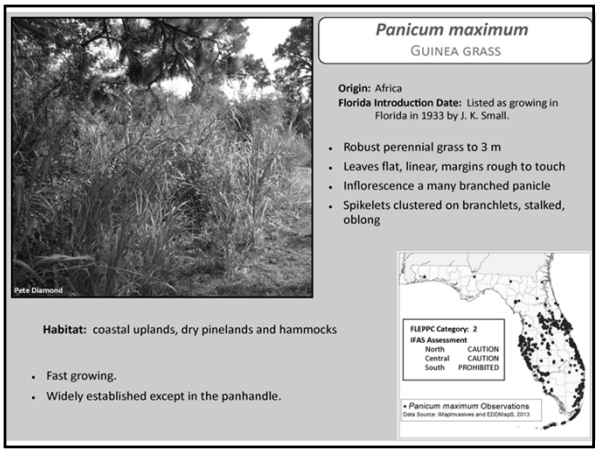
- Federal Noxious Weed.
- Forms dense floating mats that shade out submersed plants.

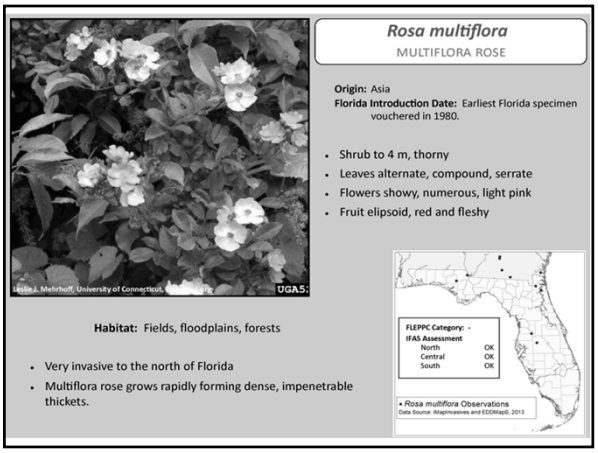

Iris pseudacorus
PALEYELLOW IRIS
Origin: Eurasia, North Africa, New Zealand
Florida Introduction Date: Probably by the mid-20th century
Long sword-shaped leaves arise from a thick rhizome
Flowers showy and yellow
Typical iris flowers
Petals usually have purple veins and an orange spot at the base
Nancy Loewenstein, Auburn University, Bugwood.org
Joseph M. DiTomaso, University of California - Davis, Bugwood.org
Habitat: riparian areas, usually on wet soil
Paleyellow iris tolerates low oxygen levels.
Glycoside levels in leaves make these plants unpalatable to livestock.
FLEPPC Category: -
IFAS Assessment
North -
Central -
South -
Iris pseudacorus Observations
Data Source: iMapInvasives and EDDMapS, 2014
Florida Natural Areas Inventory - www.fnai.org - June 2014


Melinis repens
NATAL GRASS
Origin: Africa
Florida Introduction Date: 1875
Short-lived perennial grass to 1 m
Leaves and stems pale green
Inflorescence a loose terminal panicle, purple to pinkish
Spikelets covered with wavy hairs, glumes with short awns
FNAI
Habitat: wide variety of mostly dry disturbed uplands
Newly establishing in the north.
Widely established in central and south.
FLEPPC Category: 1
IFAS Assessment
North -
Central -
South -
Melinis repens Observations
Data Source: iMapInvasives and EDDMapS, 2013


Myriophyllum spicatum
EURASIAN WATER MILFOIL
Origin: Eurasia and Africa
Florida Introduction Date: 1940s
Perennial, submersed aquatic herb
Forms dense mats just below the water surface
Submersed leaves in whorls of 3 or 4
Flowers tiny, solitary, in leaf axils
Steven Lovell, Alabama Department of Conservation and Natural Resources, Bugwood.org
Habitat: lakes, streams, brackish water
Similiar to nonnative M. aquaticum, and to the native Myriophyllum species.
Spreads and reproduces mainly by regrowth of plant fragments.
FLEPPC Category: 2
IFAS Assessment
North PROHIBITED
Central PROHIBITED
South PROHIBITED
Myriophyllum spicatum Observations
Data Source: iMapInvasives and EDDMapS, 2014
Florida Natural Areas Inventory - www.fnai.org - June 2014


Paederia foetida
SKUNKVINE
Origin: Eastern and southern Asia
Florida Introduction Date: Before 1897.
Semi-woody vine to 7 m
Leaves opposite, stalked, entire, oval to linear -lanceolate
Flowers small, stalked, tubular, pink to lilac with darker throat
Fruit shiny capsule, yellowish-orange
FNAI
Habitat: Sandhill, floodplain, upland mixed forest
Recently spreading into parts of North Florida.
FLEPPC Category: 1
IFAS Assessment
North PROHIBITED
Central PROHIBITED
South PROHIBITED
Paederia foetida Observations
Data Source: iMapInvasives and EDDMapS, 2013


Panicum maximum
GUINEA GRASS
Origin: Africa
Florida Introduction Date: Listed as growing in Florida in 1933 by J. K. Small.
Robust perennial grass to 3 m
Leaves flat, linear, margins rough to touch
Inflorescence a many branched panicle
Spikelets clustered on branchlets, stalked, oblong
Pete Diamond
Habitat: coastal uplands, dry pinelands and hammocks
Fast growing.
Widely established except in the panhandle.
FLEPPC Category: 2
IFAS Assessment
North CAUTION
Central CAUTION
South PROHIBITED
Panicum maximum Observations
Data Source: iMapInvasives and EDDMapS, 2013


Rosa multiflora
MULTIFLORA ROSE
Origin: Asia
Florida Introduction Date: Earliest Florida specimen vouchered in 1980.
Shrub to 4 m, thorny
Leaves alternate, compound, serrate
Flowers showy, numerous, light pink
Fruit elipsoid, red and fleshy
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
UGA5
Habitat: Fields, floodplains, forests
Very invasive to the north of Florida
Multiflora rose grows rapidly forming dense, impenetrable thickets.
FLEPPC Category: -
IFAS Assessment
North OK
Central OK
South OK
Rosa multiflora Observations
Data Source: iMapInvasives and EDDMapS, 2013

Salvinia molesta

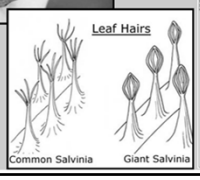
GIANT SALVINIA

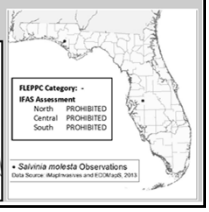
Origin: Brazil
Florida Introduction Date: Earliest Florida specimen vouchered in 2000.

- Floating fern forming mats
- Rootless stems to 10 cm
- Leaves in 3's, rounded, folded along midrib
- Hairs on upper leaf surface joined at tips, resembling a basket

Habitat: Lakes, rivers

- Vouchered only in 2 counties.
- Noxious weed in other regions.
- Spread by watercraft.





Schinus terebinthifolius

BRAZILIAN PEPPER

Origin: Brazil, Argentina, Paraguay
Florida Introduction Date: 1840s

- Shrub or small evergreen tree to 13 m
- Leaves alternate, compound, often winged, oblong, aromatic
- Flowers white, small
- Fruit a round, red, drupe

Habitat: wide variety of habitats; mainly wetlands and coastal uplands

- Widely established except in panhandle and colder north central part of state.
- Some people experience allergic reactions to the sap.
- Trees produce enormous quantities of bird-dispersed fruit.

Solanum viarum

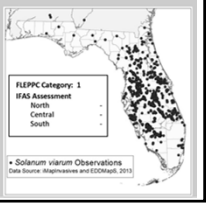
TROPICAL SODA APPLE

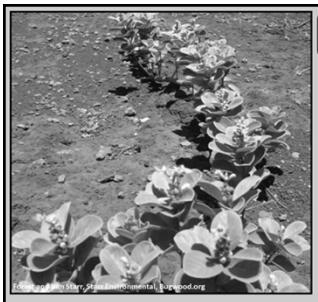
Origin: Brazil, Argentina, Paraguay
Florida Introduction Date: Earliest Florida specimen vouchered in 1988.

- Herbaceous prickly, perennial, to 1 m
- Leaves simple, alternate, oval-triangular, armed, velvety
- Flowers in small clusters, white, 5-petaled, cream-colored
- Fruit a round berry, green with dark veins, ripening to yellow

Habitat: Disturbed flatwoods and pastures

- Spreads extremely fast.
- Livestock and wild animals eat fruits and readily disperse seed.
- Established widely in central and south Florida.





Vitex rotundifolia

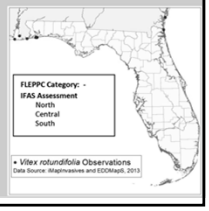
BEACH VITEX

Origin: Japan, SE Asia, India, Pacific islands
Florida Introduction Date: 1980s in North Carolina

- Deciduous, sprawling, shrub, rooting at nodes
- Leaves opposite, blue-green, pubescent, aromatic
- Flowers blue-purple in terminal panicles
- Fruits small, blue-black

Habitat: beach dune

- Can colonize beach foredunes, established in North and South Carolina.



Captive Wildlife Invasive Species

Invasive Species History

- A nonnative species could become invasive soon after becoming established, like the Cuban tree frog. It was introduced in 1931 through packing materials, and has invaded Florida's natural areas, preying on our native tree frogs. Cuban tree frogs rapidly spread in south Florida and were common throughout most of the state by the 1970's.
- On the other hand, it might take years for the right factors to fall into place to allow a species to expand its range and cause ecological problems. For example, green iguanas have resided in Florida since the 1960's, but their population has increased greatly since Hurricane Andrew. Although green iguanas have not had ecological impacts, this Central and South American lizard causes significant economic damage to landscape plants, primarily in Miami-Dade and Broward Counties. On Florida's west coast, black spinytail iguanas have reached such abundance that many residents view them as a nuisance, and the town of Boca Grande has considered hiring trappers to remove them.
- Some invasive animals do not cause problems in all areas. The nutria, a large rodent from South America, lives in warm, marshy areas. It is abundant in the lowlands of Louisiana and Mississippi, but Florida populations have not been very successful even though Florida has similar habitats to other Gulf Coast states.

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Conditional (Invasive) Species

- Snakes:

  Indian or Burmese Python

  Reticulated Python

  African Rock Python

  Amethystine/ Scrub Python

  Green Anaconda

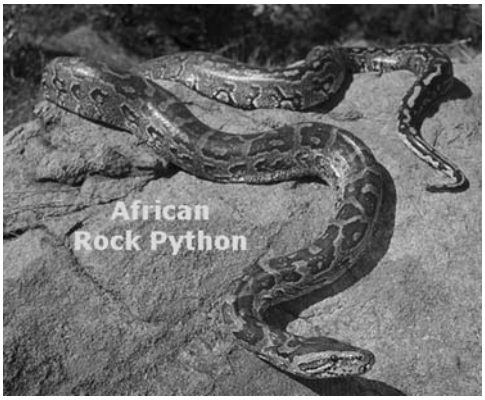
  Nile monitor

Burmese Python

Burmese (Alt. Color Patterns)

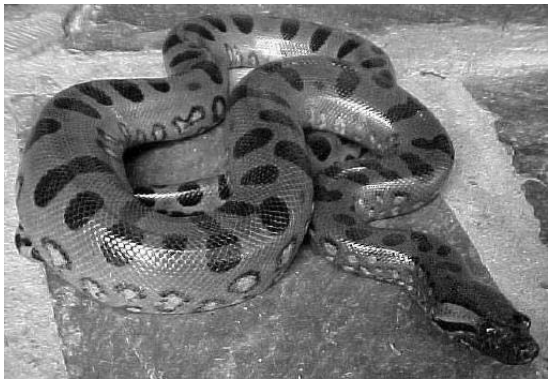
Reticulated Python

African Rock Python



Amethystine/ Scrub Python

Green Anaconda



Ball Python

Nile Monitor

Red Ear Sliders

Local Cases with Invasive Species

12 Ft. Green Burmese

8 Foot Albino Burmese

Tegu's

Slider Turtles

FWC Sites For Invasive List

- Myfwc.com- enter Invasive Species in search area.
- (1-888-IVE-GOT-1) Hotline for reporting Non-native snakes and wildlife

Power of Partnerships

Rose Godfrey
UF/IFAS Invasive Species Coordinator
School of Forest Resources & Conservation (SFRC)
Florida Invasive Species Partnership (FISP)

UF | IFAS Extension
UNIVERSITY of FLORIDA

Our Mission

The **Cooperative Extension Service** is a federal, state, and county partnership dedicated to developing knowledge in agriculture, human and natural resources, and the life sciences and to making that knowledge accessible to sustain and enhance the quality of human life.

SFRC School of FOREST RESOURCES & CONSERVATION

FISP Mission Statement

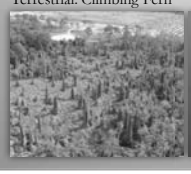
Improve the efficiency and effectiveness of preventing and controlling invasive non-native species through partnering to increase communication, coordination and use of shared resources in order to protect wildlife habitat, working agricultural and forest lands, natural communities and biodiversity in Florida.

Treasure Coast CISMA

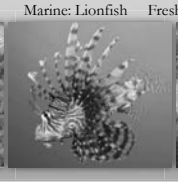
Invasive Non-Native Species

- A Species outside of its natural range or natural zone of dispersal that forms self-sustaining and expanding populations within a natural community in its new range. (Vitousek et al. 1995)
- … and whose introduction does or is likely to cause economic or environmental harm or harm to human health. (Executive Order 13112)

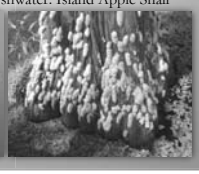
Terrestrial: Climbing Fern



Marine: Lionfish



Freshwater: Island Apple Snail



The Evolution of FISP

- 2001 Invasive Species Working Group
  - Federal & state agencies one strategic plan for prevention and management of all biological invasions in Florida
  - Primarily ***public*** lands
- 2006 Private Land Incentive Group
  - Invasive species management on ***private*** lands
  - ***Promoted partnerships*** between public land managers, resource managers and private land managers
- 2008 The Florida Invasive Species Partnership
  - Public *and* private lands
  - Maintains same partnership focus

FISP Goals

- Encourage voluntary partnerships to increase effectiveness and decrease costs of comprehensive invasive species management;
- Provide tools and resources that enable the development of unified approaches, bridging the gap between private landowners' and land management agency invasive species efforts; and,
- Encourage the development, implementation and sharing of new and/or innovative approaches to address the threat of invasive species.

Everglades CISMA – Joint Work Day

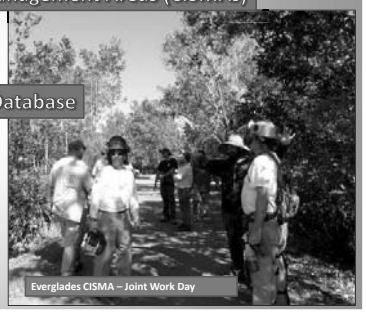
FISP Goals

- Encourage voluntary partnerships to increase effectiveness and decr
- Provide tools and resources that enable the development of unified approaches, bridging the gap betw land management agency invasive species efforts; and,
- Encourage the development, impl and/or innovative approaches to address the threat of invasive species.

Cooperative Invasive Species Management Areas (CISMAs)

Landowners Assistance Online Database

Online Reporting - EDDMapS



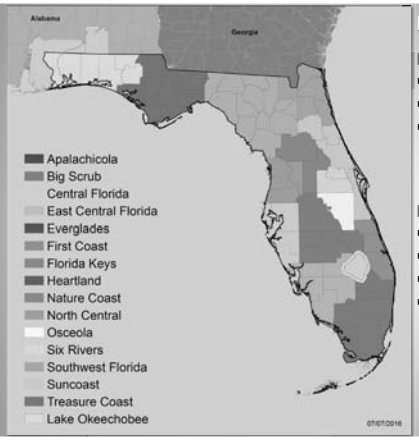
Everglades CISMA – Joint Work Day

Cooperative Invasive Species Management Areas - CISMAs

A partnership of federal, state, and local government agencies, tribes, individuals, and various interested groups that manage noxious weeds or invasive species in defined area.

Keys Invasive Species Task Force – partner work day

First Coast ISWG – Tamarisk Work Day



Florida's CISMAs

By the Numbers:

- 16 CISMAs
- 100% of state
- Average 4 counties per CISMA

Examples of Efforts:

- Workdays
- Workshops
- Prioritization
- Outreach

FISP Website:
www.FloridaInvasives.org

Florida Landowner Incentive Programs

Each year, multiple agencies and organizations provide cost-sharing programs, grants and/or technical assistance to help private landowners and public land managers with resource management. Invasive species management is an important component of many of these programs.

This online tool, which is updated quarterly, is intended to connect landowners and land managers with financial and technical support. Insert your county name, target species and other information to retrieve a list of programs. This resource is regularly updated to provide current opportunities and contacts.

Incentive Program Search Form

Property Location:

Any Florida Counties

Invasive Species:

By Common Name

By Scientific Name

Cost-Share Required:

Yes No

Management Plan Required:

Yes No

Sort Results By:

Program Agency

Submit

Enter your email address here to get updates on program changes and deadlines.

email address Subscribe

Total records: 22

Current Filters:

Print this Page

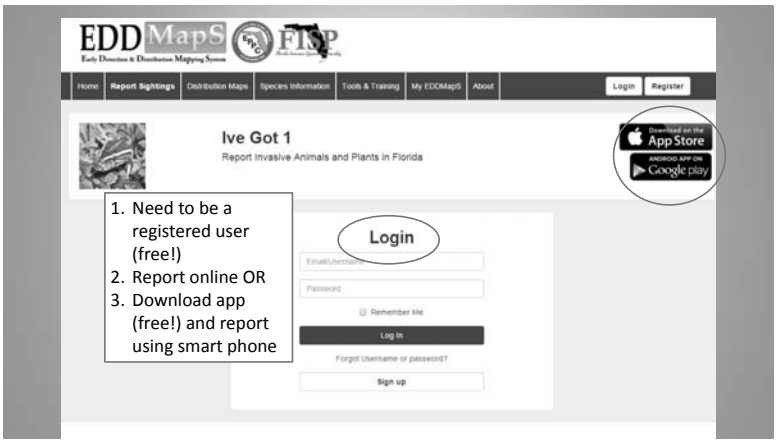
Program	Agency
Bradford County Invasive Plant Control Initiative	Bradford Soil and Water Conservation District
Pilot Cogongrass Treatment Cost-Share Program	Florida Department of Agriculture and Consumer Services, Florida Forest Service
Landowner Assistance Program (LAP)	Florida Fish and Wildlife Conservation Commission (FFWCC)
Forest Stewardship Program	Florida Forest Service
Southern Pine Beetle Assistance and Prevention Program	Florida Forest Service
FNPS Conservation Grant Program	Florida Native Plant Society
Environmentally Endangered Lands Covenant	Miami-Dade County Permitting, Environment and Regulatory Affairs
Bring Back the Natives	National Fish and Wildlife Foundation (NFWF)
NOAA Restoration Center Community-based Program	
Working Lands for Wildlife	

FISP Website:
www.FloridaInvasives.org

Environmental Quality Incentive Program (EQIP)

Print this Page

Agency Name	Natural Resources Conservation Service (USDA-NRCS)
Affiliation	federal government
Web Site	http://www.nrcs.usda.gov/programs/eqip/
Project Annual Funding Level	varies
Range of Funding (Landowner)	up to $ 300,000
Criteria for funding project	Persons that are engaged in livestock or agricultural production on eligible land.
Geographic Coverage Area	All counties in Florida. National coverage.
Description of Program	EQIP provides cost sharing to help farmers with conservation practices. All sign-ups are conducted at USDA Service Centers in Florida. Farmers can apply for cost-sharing for many types of conservation practices. * Organic Initiative-helps producers install conservation practices on USDA certified organic operations or those working toward organic certification. * Seasonal High Tunnel Initiative-helps producers install high tunnels designed to extend the growing season, increase productivity, keep plants at a steady temperature, and conserve water and energy. * Orchard Energy Initiative-helps producers conserve energy on their operations. * Longleaf Pine Initiative-helps private landowners improve the sustainability and profitability of Longleaf pine forest ecosystems. * Gulf of Mexico Initiative-helps producers located in the Escambia River and Middle Suwannee River Area watersheds to focus on reducing soil erosion, improving soil health, improving water quality, and wildlife habitat on cropland, pastureland and forestland.
When are landowner applications accepted?	Continuous throughout the year. Batching period usually ends at the end of October each year. *Check your local NRCS office for more accurate application dates. * The EQIP Initiatives application deadline for fiscal year 2014 is February 21, 2014.
Match Required?	No Program pays flat rate reimbursement of costs by federal grants.
Target Invasive Species?	All federal or state listed invasive species
Any other Requirements or Eligibility?	Non-federal lands (private, state, municipal or tribal lands) or federal lands when primary benefit is on associated non-federal lands on a limited basis. Must meet HEL/WC (highly erodible lands/wetland compliance) and AGI (adjusted gross income) requirements.
Agreement Required	Yes 1 to 10 years
Permanent Contact	Kenneth Morgan or Georganne Wilise



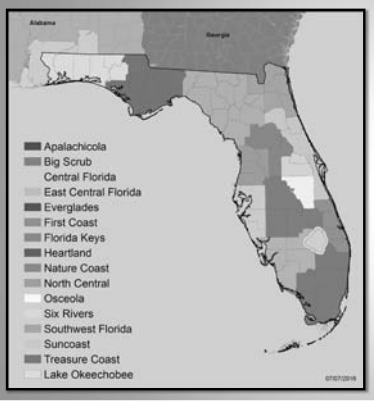
3RD ANNUAL FALL HALLOWEED COUNT

Fall HalloWeed Count

The 2016 HalloWeed count is a 2-week statewide data collection event to enter invasive plant data on EDDMapS (www.IVEGOT1.org) with the help of Florida's CISMAs

October 21, 2016 – November 6, 2016

CISMAs and You!



1. Get involved with your local CISMA.
2. Use the www.floridainvasives.org resources.
   1. Database
   2. "How To" page
3. Report invasive species on EDMapS.

FISP Think locally, Act Neighborly
invasive species know no boundaries!

Questions?

SFRC School of Forest Resources & Conservation

Rose Godfrey
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UF IFAS Extension University of Florida

FISP/CISMA Newsletters and Event Tracking
www.floridainvasives.org/success.html

CISMA Listserv: Click on "Florida CISMA Listserv"
www.floridainvasives.org/cismas.html

CISMA Monthly Calls: If you would like to see any past calls, please check them out on the FISP website
www.floridainvasives.org/cismacalls.html

FISP Facebook:
https://www.facebook.com/floridainvasives.org

Herbicide Application Techniques for Woody Plant Control[1]

Jason Ferrell, Stephen Enloe, and Brent Sellers[2]

The encroachment of trees and other woody plants into pastures, fencerows, ditch banks, rights-of-way, and other areas is a common occurrence. These woody species can be particularly troublesome and require control since they will compromise fence integrity, vehicle safety, impede canal drainage, interfere with transmission of electricity. Additionally, some species (such as cherry trees) are highly poisonous to livestock. The aim of this publication is to detail the techniques for the removal of woody plants. For information on controlling similar species in natural areas or in forestry settings, consult UF/IFAS publications SP242, *Integrated Management of Nonnative Plants in Natural Areas of Florida* (http://edis.ifas.ufl.edu/wg209) and Circular 1477, *Primer on Chemical Vegetation Management in Florida Pine Plantations* (http://edis.ifas.ufl.edu/fr160).

Control of woody perennials can be difficult, but several control techniques are available. Mowing is a commonly used control procedure for small brush because the equipment is readily available and the results are immediate. However, this method generally provides only short-term success because it leaves live stumps and root-stocks that re-sprout. Mowing some species, like Chinese tallow, worsens the situation by replacing a single stemmed plant with a stump with multiple re-sprout stems. Another strategy that can reduce some troublesome species is fire. However, fire can be tricky to manage, and it is difficult to generate a fire with sufficient heat capacity to kill most hardwood species along fencerows, ditch banks, and other sites with low plant density.

Herbicides are often the most effective and inexpensive means of controlling woody plants. There are several application techniques that can be used to control trees and brush of various sizes. Not all brush species are equally susceptible to herbicides. Therefore, results may vary for any of these application methods, relative to brush size and species. Each application technique will be subsequently discussed.

Foliar Application

Foliar application directs an herbicide/water mixture directly onto the leaves of a plant (Figure 1). This technique can be highly effective on smaller species (6 to 8 feet in height). Auxin-type herbicides (such as triclopyr) are generally most effective early in the season, while enzyme-inhibiting herbicides (imazapyr and others) are most effective in the late summer or fall. Glyphosate is most effective in late summer or fall, prior to change in leaf color for deciduous species.

1. This document is SS-AGR-260, one of a series of the Agronomy Department, UF/IFAS Extension. Original publication date January 2006. Revised December 2015. Visit the EDIS website at http://edis.ifas.ufl.edu.

2. Jason Ferrell, professor; Stephen Enloe, associate professor, Agronomy Department; and Brent Sellers, associate professor, Agronomy Department, Range Cattle Research and Eduation Center; UF/IFAS Extension, Gainesville, FL 32611.

Figure 1. Foliar application with a backpack sprayer.
Credits: Stephen Enloe, UF/IFAS

Adequate control with foliar applications can be difficult to accomplish. This is because complete coverage of all foliage is essential for control, but over-application (which leads to spray runoff) will reduce effectiveness. Therefore, foliar applications commonly require multiple follow-up treatments before control is accomplished. It is important to control spray drift when making foliar applications. Certain desirable hardwood and crop species are highly sensitive to spray drift and can be inadvertently damaged. It is also advisable to include a tracer dye with the spray solution to ensure that some plants are not sprayed twice while others are missed entirely.

What about mowing before treatment? Mowing decreases foliage while maintaining a large root mass, making control even more difficult. If plants have been mowed, it is important to allow them to regrow to a height of 3 or 4 feet before herbicide application.

Basal Application

Basal application combines the herbicide with an oil penetrant and applies the mixture directly to the bark of a standing tree. For trees that are less than 6-inches in diameter and have smooth bark, this method is frequently successful. However, it is important that the lower 12 to 18 inches of the stem be treated on all sides with the herbicide/oil mixture (Figure 2). Adequate coverage is essential, since treating only one side of the stem will result in controlling only half of the tree. Basal applications can be made any time of the year, but control may be reduced when trees are flushing new growth in the spring. Winter is often the easiest time to do basal treatments as temperatures are cooler and many tress and surrounding herbaceous plants are dormant.

Basal applications will not provide rapid control. Herbicide injury is often not observed for several weeks after treatment, and complete control may require several months. Additionally, basal treatment is not effective on older trees greater than six inches in diameter or trees with very thick bark. For these situations, other application techniques should be employed.

Figure 2. Basal bark application with herbicide/oil mixture.
Credits: Stephen Enloe, UF/IFAS

Hack and Squirt

The hack-and-squirt technique is ideal for control of large trees that cannot be managed with basal applications. This method requires that you use a machete or hatchet to cut through the thick bark and into the sapwood. The hacks should be made at a downward angle of approximately 45 degrees. This will create a "cup" to hold the herbicide solution. If the hack does not hold herbicide solution, the treatment will not be effective. Most labels specify 0.5 to 1.0 ml of solution per hack. This is important to note, as small spray bottles commonly sold in garden supply stores may apply as much as 3.5 ml per stroke. This makes accurate application very difficult, but the most important aspect is not to overfill the hack. The recommended spacing of hacks around the circumference of the tree is specified on the herbicide label and may be described as slightly overlapping, continuous, or evenly spaced. (Figure 3) The addition of a basal oil is not recommended for this procedure.

This method of application is advantageous because it is highly selective and injury to surrounding species is not common. It can also be done at any time during the year,

but effective treatment of some species in the spring can be reduced because of heavy sap flow pushing the herbicide from the cut surfaces. Finally, the hack and squirt method should only be used where dead standing trees are acceptable from an aesthetic and safety standpoint. Therefore, it is not recommended along roadsides or in parks where hazard trees cannot be tolerated.

Figure 3. Hack-and-squirt application technique.
Credits: Stephen Enloe, UF/IFAS

Cut Stump

This technique is employed after cutting a tree to eliminate, or greatly reduce, resprouts from the stump or lateral roots. The herbicide should be applied to the cut surface as quickly as possible after the sawdust has been removed. If applied immediately, an herbicide/water solution is sufficient. If herbicide treatment is delayed and the cut surface has begun to dry, an herbicide/basal oil mixture must be used instead and applied to the top and around the collar of the stump.

For stumps greater than 3 inches in diameter, thoroughly wet the outer edge while avoiding herbicide runoff (Figure 4). This is because the only living tissue in larger trees is around the outer edge. Covering the entire cut surface will require more herbicide, most of which will provide little effect. For smaller stems it is appropriate to cover the entire cut surface (Figure 5). For this procedure, herbicides can be applied using a backpack sprayer, squirt bottle, or paint brush. Regardless of how the herbicide is applied, a tracer dye should be included to ensure treatment of all individual stumps.

Figure 4. Application of herbicide to larger cut stumps only requires treatment of the outer edge.
Credits: Stephen Enloe, UF/IFAS

Figure 5. Application of herbicide to smaller stumps requires complete coverage.
Credits: Stephen Enloe, UF/IFAS

Table 1. Recommended herbicides for each application procedure.

Herbicide	Application Rate	Comments
Foliar Application		
Imazapyr (Arsenal, others)	1–3%	Excellent control of sweetgum and maples. Use higher rates for oaks and cherry. A non-ionic surfactant is required.
Glyphosate (Several)	5–8%	Cover as much of the foliage as possible and spray until wet. If the brush has been cut, delay application for approximately 1 year. Retreatment is commonly required control.
triclopyr + 2,4-D (Crossbow)	1–1.5%	For control of various herbaceous and woody species. This product contains 2,4-D ester; precautions to manage drift must be employed. Repeat applications are often required.
Triclopyr ester (Remedy Ultra, others)	0.5–2%	Best when applied in late spring or early summer. If the brush has been cut, delay application for approximately 1 year. Thoroughly wet all leaves, but not to the point of runoff.
Triclopyr + fluroxypyr (Pasturegard HL)	2–4 qt/100 gal of spray	
Aminocyclopyrachlor Method 240 SL	8–16 oz/100 gal of spray	For best results, apply near the top of the tree and allow the spray to trickle down into the canopy. Full coverage of canopy is necessary, but do not allow runoff. Apply with 1% v/v methylated seed oil (MSO).
Aminopyralid Milestone	0.25–0.75% solution	For control of a wide variety of woody plants. For best results, mix with glypohosate (3-5%) and imazapyr (0.5%) or triclopyr at 1% plus a surfactant. Do not exceed 7 oz/A of Milestone.
Basal Bark		
Imazapyr (Stalker, others)	8–12 oz/gal	Best for trees less than 4 inches DBH (diameter at breast height). Be aware that imazapyr is highly active in the soil. If desirable plants are near to a treated individual, it is possible for the herbicide to wash off into the soil and injure or kill the desirable plant. Make sure to choose an imazapyr product that is soluble in basal oils.
Aminocyclopyrachlor Method 240 SL	10–20% solution	Best for trees less than 6 DBH. Spray until run-off at the ground line is noticeable. This herbicide significant soil activity, so be aware that desirable trees in the vicinity may be injured by these applications.
Triclopyr ester (Pathfinder)	100%	Pathfinder is a "ready to use" product that is formulated and dosed correctly for this type of application. Apply Pathfinder at 100% strength as directed.
Triclopyr ester (Remedy Ultra or others)	25% + 75% basal oil	Best for trees less than 6 inches DBH. Generally most effective 6 weeks prior to leaf expansion, until 2 months after. Most effective on trees with smooth bark. Thick bark trees may require retreatment. These herbicides have little or no soil activity.
Triclopyr + fluroxypyr (Pasturegard HL)	25% + 75% basal oil	
Hack-and-Squirt		
Imazapyr 4 lb/gal (Arsenal AC)	6 oz/gal	One hack per 3 inches DBH.
Triclopyr amine (Garlon 3A, others)	50–100%	One hack per 3 or 4 inches DBH. Apply 0.5 ml undiluted herbicides or 1 ml of 50% solution in water.
Hexazinone (Velpar)	100%	One hack per 4 inches DBH. Use undiluted herbicide.
Glyphosate (several)	50%	1 ml per 2 or 3 inches DBH, applied below the branches. For larger trees, best results are observed from applying glyphosate in a continuous frill around the stem.
Aminopyralid (Milestone)		Make a series of slightly overlapping hacks around the trunk. Apply 1 ml of the solution per hack.

Cut Stump		
Imazapyr (Arsenal AC or Stalker)	6 oz/gal (for Arsenal AC) or 8-16 oz/gal (for Stalker)	Apply to the top and side of a freshly cut stump. Garlon 3A is excellent for this use. If surface of stump has began to dry prior to herbicide treatment, apply Chopper or triclopyr ester product in basal oil or recut the stump and apply to the freshly cut surface. Garlon 3A will not effectively mix with basal oils.
Triclopyr amine (Garlon 3A)	50–100% in water	
Triclopyr ester (Remedy Ultra or others)	25% solution in water or basal oil	
Triclopyr + fluroxypyr (Pasturegard HL)	25% solution in water or basal oil	
Aminocyclopyrachlor Method 240 SL	5–10% solution in basal oil	Spray the stump surface and thoroughly wet the cambium layer all the way around.
Glyphosate (several)	50–100%	Apply to cut stumps immediately after cutting. Glyphosate is not effective on stumps that have started to dry after cutting. If immediate treatment is not possible, other herbicides should be selected since glyphosate will not mix with basal oils.
Aminopyralid (Milestone)	10%	Apply solution to cambium area around the entire circumference of the stump. Apply immediately after cutting.

Cogongrass (*Imperata cylindrica*) Biology, Ecology, and Management in Florida Grazing Lands[1]

B. A. Sellers, J. A. Ferrell, G. E. MacDonald, K. A. Langeland, and S. L. Flory[2]

Cogongrass is found on every continent and is considered a weedy pest in 73 countries. In the U.S., cogongrass is found primarily in the Southeast. It was accidentally introduced into Alabama in the early 1900s, and purposely introduced as a potential forage and soil stabilizer in Florida (and other states) in the 1930s and early 1940s. However, soon after investigations began it was realized that cogongrass could be a weedy pest. Since its introduction, cogongrass has spread to nearly every county in Florida. In some cases, it has completely taken over pastures so that it is the only species present. This is a common thread where cogongrass invades; it quickly displaces desirable species and requires intensive management.

There are many reasons why cogongrass is such a prolific invader. It is a warm-season, perennial grass species with an extensive rhizome root system. In fact, at least 60% of the total plant biomass is often found below the soil surface. In addition to the rhizome root system, cogongrass adapts to poor soil conditions, and its fires burn so hot that they eliminate nearly all native species. Cogongrass is drought tolerant and has prolific wind-dispersed seed production. Additionally, it can grow in both full sunlight and highly shaded areas, although it is less tolerant to shade.

Cogongrass spreads through its creeping rhizome system and seed production. The rhizomes can penetrate to a depth of 4 feet, but most of the root system is within the top 6 inches of the soil surface. The rhizomes are responsible for long-term survival and short-distance spread of cogongrass. Long-distance spread is accomplished through seed production. Seeds can travel by wind, animals, and equipment. Seed viability is significant in north Florida and other states of the Southeast; however, there are no confirmed cases of viable seed production in central and south Florida.

An established cogongrass stand invests heavily in its perennial root system. These infestations are capable of producing over 3 tons of root biomass per acre. This extensive network of rhizomes is capable of conserving water while the top growth dies back during prolonged drought. This is essentially a survival mechanism to keep the rhizome system alive. Another key to cogongrass invasion is that the root system may produce allelopathic chemicals that reduce the competitive ability of neighboring plants.

Identification

Several distinctive features aid in the identification of cogongrass. First, cogongrass infestations usually occur in circular patches. The grass blades tend to be yellow to green in color (Figure 1). Individual leaf blades are flat and

1. This document is SS-AGR-52, one of a series of the Agronomy Department, UF/IFAS Extension. Original publication date April 2002. Revised August 2012. Reviewed October 2015. Visit the EDIS website at http://edis.ifas.ufl.edu.

2. B. A. Sellers, associate professor, Agronomy Department, Range Cattle Research and Education Center; J. A. Ferrell, professor; G. E. MacDonald, professor; K. A. Langeland, professor; and S. L. Flory, assistant professor, Agronomy Department; UF/IFAS Extension, Gainesville, FL 32611.

serrated, with an off-center prominent white midrib (Figure 2). The leaves reach 2–6 feet in height. The seed head (Figure 3) is fluffy, white, and plume-like. Flowering typically occurs in spring or after disturbance of the sward (mowing, etc.). Seed heads range from 2 to 8 inches in length and can contain up to 3,000 seeds. Each seed contains silky-white hairs that aid in wind dispersal. When dug, the rhizomes (Figure 4) are white, segmented (have nodes), and are highly branched. The ends of the rhizome are sharp pointed and can pierce the roots of other plants.

Figure 1. Cogongrass plants are yellow to green in color. Note that the edges of the leaf tend to have more yellow than green.
Credits: G. Keith Douce, University of Georgia, www.forestryimages.org.

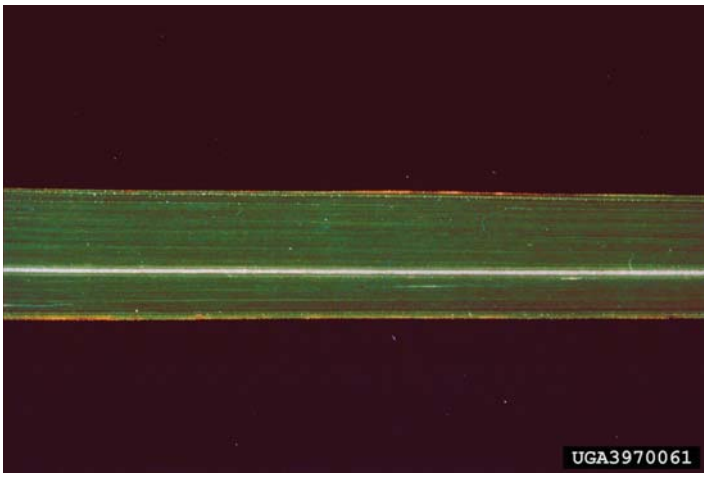

Figure 2. Cogongrass leaves have serrated edges and a prominent, white, off-center midrib.
Credits: L. M. Marsh, Florida Department of Agriculture and Consumer Services, www.forestryimages.org.

Figure 3. Cogongrass seed heads are fluffy and white. Each plant produces nearly 3,000 seeds.
Credits: John D. Byrd, Mississippi State University, www.forestryimages.org.

Figure 4. Cogongrass rhizomes are segmented (have nodes) where new shoots are able to grow.
Credits: Chris Evans, River to River CWMA, www.forestryimages.org.

Forage Value

Cogongrass has been used in Southeast Asia as forage because it is the dominant vegetation on over 300 million acres. In these areas it was found that only very young shoots should be grazed or cut for hay. At this stage, the leaves lack sharp points and razor-like leaf margins. For about four weeks following a prescribed burn, crude protein of regrowth is comparable to bahiagrass. Crude protein of mature stands rarely attains the minimal 7% level needed to sustain cattle, making supplementation essential for livestock production. Cogongrass yields are relatively

low, even under heavy fertilization, and usually do not exceed 5 tons per acre.

Management

For many years researchers all over the world have studied cogongrass control. During this time nearly all available herbicides have been tested, but few effective products have been found. For example, all of the commonly used pasture herbicides such as metsulfuron, 2,4-D, triclopyr, Velpar, and other combinations have little to no activity on cogongrass. Only glyphosate (Roundup, etc.) and imazapyr (Arsenal, Stalker, etc.) herbicides have been found to be effective, but long-term control is rarely achieved.

Imazapyr is an extremely effective herbicide that controls a variety of weeds, from herbaceous to woody species. One or two applications of imazapyr (0.75 lb/acre) will often effectively control cogongrass for 18–24 months. However, there are several disadvantages to using this herbicide. First, imazapyr will severely injure or kill forage grasses such as bermudagrass and bahiagrass. It also has a long soil half-life and will remain in the soil for several months after application. This often leads to "bare ground" for up to 6 months in the application area because of the non-selective nature of this herbicide. Imazapyr also has the potential to move down slopes during periods of rainfall, killing or injuring other species in the runoff area (oaks and other hardwood trees are especially sensitive). Second, imazapyr can only be used as a "spot-treatment" with no more than 10% of the pasture area treated per year.

Similarly, glyphosate is also a non-selective herbicide that effectively controls a variety of weeds. Unlike imazapyr, glyphosate possesses very little to no soil activity. Non-target effects caused by runoff during high rainfall events are not likely. Since glyphosate has no soil activity, it does not take very long for weeds or desirable grasses to reinfest the treated areas. Cogongrass will likely reinfest the area if only one application of glyphosate is applied during the same year. Research in Alabama has revealed that it takes approximately three years of two applications per year to reduce cogongrass rhizome biomass by 90%.

Small Infestations

Early detection of cogongrass in any setting is extremely important. A young infestation will be much easier to treat and eradicate than established infestations. In this case, we would define a small patch as 20–30 feet or less in diameter. Even for a small patch, monitoring is required after the initial application to ensure that any re-sprouting is quickly treated. See Table 1 for specific timelines and suggested herbicide rates.

Large Infestations

Large infestations are 30 feet or larger in diameter. These types of infestations can be considered as established and likely have a large, intact root system. This will require more herbicide treatments to completely eradicate cogongrass. See Table 2 for specific timelines and suggested herbicide rates.

Integrated Management

Herbicide inputs alone are rarely successful in eradicating perennial species like cogongrass. In these cases, we need to use all of the tools we have to remove an unwanted species to reestablish a desirable species. This type of strategy is best employed in an area where cogongrass has long been established and is the predominant species present. See Table 3 for specific timelines and suggested herbicide rates.

In general, burn the area infested with cogongrass in August to September. One to four months later, treat the burned area with a mixture of imazapyr and/or glyphosate. Take soil samples prior to spring tillage the next growing season to ensure that the soil pH is adequate for your desirable forage species. Till the treated area the following spring to a depth of at least 6 inches and prepare a seedbed.

Consult with your local county Extension agent to consider your options for forage cultivars and fertility recommendations. Getting a good start on the desirable forage will help limit cogongrass reinfestations in your pasture. Continue to monitor this area in six-month intervals until the fourth year. Spot treat with glyphosate when necessary to remove any new cogongrass growth.

Table 1. Herbicide suggestions for small infestations of cogongrass in grazing areas. This includes both improved and native rangeland. These concentrations are good for mixing in small (3–30 gallon) sprayers. Please read the entire label of the suggested products prior to treating existing cogongrass stands.

	Timing	Herbicide Rate	Application Notes
1st year	Fall (August–November)	1% Arsenal/Stalker + 0.25% non-ionic surfactant	Treat only 10% of the area to be grazed. No grazing restrictions, but do not cut for hay for 7 days. Read the herbicide label for mixing instructions.
		3% glyphosate	No grazing or haying restrictions. Read the herbicide label for mixing instructions.
		0.5% Arsenal/Stalker + 2% glyphosate + 0.25% non-ionic surfactant	Treat only 10% of the area to be grazed. No grazing restrictions, but do not cut for hay for 7 days. Read the herbicide label for mixing instructions.
2nd year	Spring (monitor regrowth)	2–3% glyphosate	See above.
	Fall (monitor regrowth)	2–3% glyphosate	See above.
3rd year–until eradicated	Spring–Fall (monitor regrowth)	Spot treat at the above rates for the 2nd year.	

Table 2. Herbicide suggestions for large cogongrass infestations in grazing areas, including both improved and native rangeland. These suggestions are intended for large (>1000 gallon) sprayers. Please read the entire label of the suggested products prior to treating existing cogongrass.

	Timing	Herbicide Rate	Application Notes
1st year	Fall (August–November)	48 oz/acre Arsenal/Stalker + 0.25% non-ionic surfactant	Treat only 10% of the area to be grazed. No grazing restrictions, but do not cut for hay for 7 days. Read the herbicide label for mixing instructions.
		3 to 4 qt/acre glyphosate	Do not graze for 8 weeks. Read the herbicide label for mixing instructions.
		24 oz/acre Arsenal/Stalker + 2 qt/acre glyphosate + 0.25% non-ionic surfactant	Treat only 10% of the area to be grazed. No grazing restrictions, but do not cut for hay for 7 days. Read the herbicide label for mixing instructions.
2nd year	Spring (monitor regrowth)	2–3% glyphosate	No grazing or haying restrictions.
	Fall (monitor regrowth)	2–3% glyphosate	No grazing or haying restrictions.
3rd year–until eradicated	Spring–Fall (monitor regrowth)	Spot treat at above rates for the 2nd year.	See above.

Table 3. Control of cogongrass using an integrated approach. Adjust your timelines based on your location in Florida. For example, burning should be performed earlier in north Florida than in south Florida because of the first onset of a potential killing frost. Please read all herbicide labels prior to treating cogongrass for restrictions and mixing instructions.

	Timing	Herbicide Rate	Application Notes
1st year	Summer—Fall (August–November)	1. Burn	Cogongrass fires burn extremely hot. Be sure to have firebreaks in place before attempting to burn cogongrass.
		2. Apply herbicide: 24 oz/acre Arsenal/Stalker + 2 qt/acre glyphosate + 0.25% non-ionic surfactant	Treat only 10% of the area to be grazed. No grazing restrictions, but do not cut for hay for 7 days. Read the herbicide label for mixing instructions.
		3. Take soil samples.	Have the soil pH tested at a reputable laboratory. Amend the soil as needed to grow desirable forage.
2nd year	Spring	1. Tillage	Prepare a seedbed for desirable forage species. Repeated tillage will help to desiccate any remaining cogongrass rhizomes.
		2. Plant desirable forage.	Please consult your local Extension agent for up-to-date recommendations on forage cultivars and fertility recommendations.
3rd year	Spring (monitor regrowth)	2–3% glyphosate	No grazing or haying restrictions.
	Fall (monitor regrowth)	2–3% glyphosate	No grazing or haying restrictions.
4th year–until eradicated	Spring–Fall (monitor regrowth)	Spot treat at the above rates for the 3rd year.	See above.

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Biology and Control of Japanese Climbing Fern *(Lygodium japonicum)*[1]

Patrick J. Minogue, Stella Jones, Kimberly K. Bohn, and Rick L. Williams[2]

Japanese climbing fern (*Lygodium japonicum* (Thunb.) SW.) is a non-native, invasive vine which from its introduction around 1900 has become established throughout the southeastern Coastal Plain from the Carolinas to Texas and Arkansas. It is native to eastern Asia from Japan and west to the Himalayas. It has primarily naturalized in Florida, Georgia, Alabama, Mississippi and Louisiana in counties located along the Gulf Coast (USDA Plant Database 2008). In Florida, climbing fern is widespread in north and west Florida and ranges into the south-central part of the Florida peninsula (Nelson 2000, Wunderlin 2006). It occurs in sunny or shady locations, usually in damp areas such as the edges of swamps, marshes, lakes, creeks, hammocks, and upland woodlands (Langeland and Cradock Burks, 1998).

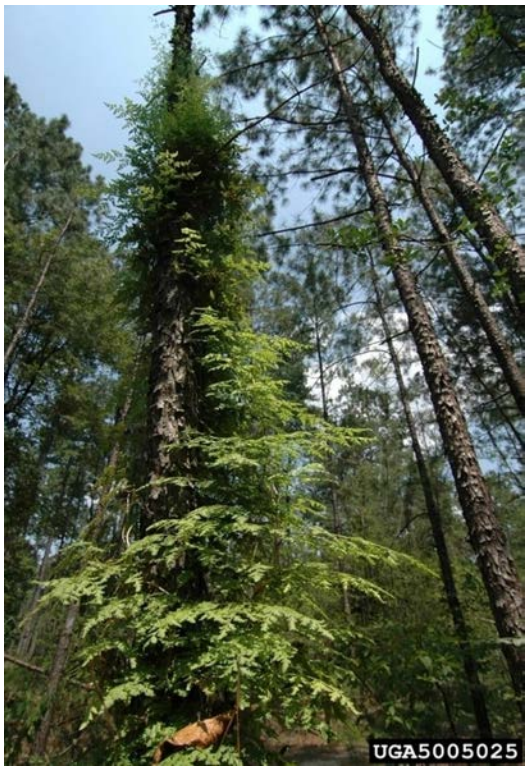

Figure 1. Japanese climbing fern, a common invasive plant in pine plantations of the Coastal Plain, has climbing, twining fronds that can grow to 90 feet long. (Photo: Ronald F. Billings, Bugwood)

Biology

Japanese climbing fern has climbing, twining fronds of indeterminate growth and can reach lengths of 90 feet. Above-ground growth occurs along wiry main stems, properly called "rachises" (the singular is "rachis"). Japanese climbing fern is closely related to

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Old World climbing fern (*Lygodium microphyllum*), another non-native invasive species in the United States. Both species are listed as Category I noxious weeds by the Florida Exotic Pest Plant Council, with the ability to "alter native plant communities, change community structures and ecosystem function" (FLEPPC 2007). Japanese climbing fern has feathery, light green fronds in contrast to the leathery appearance of Old World climbing fern, which usually has un-lobed leaflets that are glabrous (waxy) below and articulately stalked. While Old World climbing fern is limited in its northern range due to a lack of frost tolerance, Japanese climbing fern is not. Frost causes above-ground portions of Japanese climbing fern to die back but does not necessarily kill the below-ground portion of the plant.

Figure 2. Japanese climbing fern is distinguished by its feathery, light green fronds, with triangular, compound leaf branches (pinnae) and lobed, stalked leaflets (pinnules) on wiry, twining, stems (rachises), often orange to brown in color. (Photo: Ted Bodner, Bugwood)

Japanese climbing fern occurs as both individual scattered plants and as tangled masses of dense canopy which can eliminate the underlying vegetation and cover larger trees. As a fern, it reproduces by spores that are extremely numerous, long-lived, and readily disseminated. Moreover, it can reproduce by self-fertilizing. Pinnae on lower rachises are sterile; but as the rachis develops, successive new pinnae become increasingly fertile. Spore abundance increases through the growing season as the rachis grows. In north Florida, peak spore release occurs in October (Van Loan 2006). Japanese climbing fern also spreads vegetatively by rhizomes located 1 to 3 cm below the soil surface. Rhizomes spread and re-sprout after winter frosts, and the fern rapidly grows back from rhizomes after being burned (Evans et al. 2006). However, no studies have reported the spread rates of fern by these vegetative means.

Figure 3. Prescribed fire alone has not been successful in controlling Japanese climbing fern, which is a ladder fuel that allows fire to climb into the forest canopy, potentially worsening the severity of wildfire and compromising the safety of prescribed burning programs. (Photo: Chuck Bargeron)

Japanese climbing fern poses both economic and ecological threats to forests in Florida. It is especially problematic in pine plantations managed for pine straw production. For years, pine straw bales have been a suspected vector of viable Japanese climbing fern plant parts and spores (Zeller and Leslie 2004). The fern is also problematic during prescribed burning because it provides a fuel ladder to canopy trees. Further, because of its ability to engulf and out-compete native vegetation, Japanese climbing fern can be of particular concern in natural and disturbed areas where restoration of remnant populations of native species is critical.

Control Measures

Biological

Currently there are no published or on-going studies regarding biological control of Japanese climbing fern in the southeastern United States. Progress has been made, however, to identify selective biological control agents for Old World climbing fern (Pemberton, 1998). In 2007, populations of the defoliating moth from Australia,

Figure 4. The three patches of light green vegetation among the dark green junipers in this landscaping are infestations of Japanese climbing fern, which was introduced from commercial pine straw. (Photo: Pat Minogue)

Austromusotima camptozonal were released at nine locations of Old World climbing fern in Florida (Pemberton, 2007). Breeding was detected at three locations, but there was no evidence of persistence or establishment of the insect. Researchers at the USDA Invasive Plant Research Laboratory (IPRL) in Ft. Lauderdale, Florida, are examining several other insect species as well, including lygodium gall mite (*Floracarus perrepae*), lygodium saw fly (*Neostrombocerus sp.*), flea beetles (*Manobia sp.*), and stem borers. The caterpillar stage of *Neomusotima fuscolinealis* is a natural pest of *Lygodium japonicum* in Japan but has yet to be tested for potential host range and environmental safety in Florida or the southeastern United States. (Pemberton, 2002).

Fire

Fire is not thought to be an effective means for control because the fern re-grows quickly following fires. A few researchers have examined the use of fire to control Old World climbing fern with little success (Munger 2005). Stocker and others (1997) used a propane torch to burn off above-ground portions of Old World climbing fern and found that the ferns recovered speedily. Regarding efforts to control Old World climbing fern Roberts (1997) concluded that fire alone will not control this invasive weed. Control of other invasive species with significant above-ground and below-ground biomass such as cogongrass (*Imperata cylindrica*) has been enhanced by using prescribed fire in conjunction with herbicide application (Jose et al. 2002). However, citing a personal communication, Ferriter (2001) stated that prescribed burns, alone and in combination with the herbicide 2,4-D, were not effective in controlling Japanese climbing fern in pine plantations in north Florida. More research is needed to examine the combined use of herbicides and fire to control existing climbing fern plants and those that may arise from numerous, long-lived spores.

Herbicides

Herbicidal control of Japanese climbing fern has only been formally investigated by a few researchers (Valenta, et al. 2001, Zeller and Leslie 2004, Van Loan 2006, Minogue et al. 2008). In a review of herbicide treatments for Old World climbing fern, Langeland (2004) noted that glyphosate and metsulfuron methyl, used alone or in combination, were most common. The effectiveness of glyphosate treatments was observed in early studies of Japanese climbing fern, however it was also noted that metsulfuron treatments were least damaging to surrounding native vegetation (Zeller and Leslie 2004). Van Loan (2006) examined 15 herbicide treatments for selective control of Japanese climbing fern in three north Florida pine forests. She had best results using glyphosate, imazapyr, and metsulfuron methyl, herbicides that inhibit the formation of amino acids in plants. Minogue et al. (2008) examined these same herbicides for efficacy in controlling Japanese climbing fern and for their impact on associated vegetation using various herbicide rates and combinations at six locations on conserved lands in north Florida. Control of Japanese climbing fern improved linearly as the glyphosate product rate was increased from 1 percent to 4 percent of the spray solution, with nearly 100 percent cover reduction at 8 months after treatment using the 4 percent rate. Combinations of glyphosate and metsulfuron methyl were generally more effective than combinations of glyphosate and imazapyr. Damage to associated vegetation, including overstory hardwood trees not sprayed with herbicide, was greatest with imazapyr. Least injury to associated vegetation was with metsulfuron methyl. Native grasses quickly re-colonized treated plots at some locations. Miller (2003) recommends various herbicide treatments for

Figure 5. Fertile leaflets (pinnules) are contracted in shape with two rows of sporangia along the leaf margin. The light brown spores are nearly microscopic. (Photo: Pat Minogue)

the control of Japanese climbing fern (see Table 1 below).

When using Arsenal® AC or Escort®, be sure to add a surfactant (wetting agent) according to label directions to improve plant uptake. From operational experience, best results are obtained with application of these herbicides in late-season, from July to early October, prior to peak spore release. Note that Arsenal® (imazapyr) is a residual, soil-active herbicide and may damage hardwood trees if their roots extend into the treated area. Pines however, are tolerant to imazapyr.

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PLEASE READ AND FOLLOW ALL HERBICIDE LABEL DIRECTIONS

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Table 1. Herbicide control measures as described by Miller (2003). All foliage must be thoroughly covered with the spray.

Escort® XP[1] (metsulfuron methyl)	1-2 oz product /acre	Mix 0.3 to 0.6 dry oz per 3 gallons water, and as a mixture with glyphosate
Aresenal® AC[2] (imazapyr)	1% in water	Mix 4 fluid oz per 3 gallons water
Glyphosate[3], Garlon 3A[4], or Garlon 4[5] (triclopyr)	4% in water	Mix 16 fluid oz per 3 gallons water, or a combination of these herbicides

[1]Escort® XP contains 60% metsulfuron methyl as the active ingredient.

[2]Arsenal® AC contains 4 lb acid equivalent imazapyr per gallon as the active ingredient

[3]Glyphosate is the active ingredient in Roundup®, Accord®, and many other products.

[4]Garlon® 3A contains 3 lb active ingredient per gallon as an amine salt of triclopyr.

[5]Garlon® 4 contains 4 lb acid equivalent triclopyr ester per gallon as the active ingredient.

Natural Area Weeds: Chinese Tallow (*Sapium sebiferum* L.)[1]

K. A. Langeland and S. F. Enloe[2]

Introduction

Florida's natural areas—a great source of pride and enjoyment to its citizens—provide recreation, protect biodiversity and fresh water supplies, buffer the harmful effects of storms, and significantly contribute to the economic well-being of the state (Jue et al. 2001). Natural areas are protected in over ten million acres (nonsubmerged) of state, federal, local and private managed conservation lands in Florida (http://fnai.org). Unfortunately, many of these natural areas can be adversely affected when they are invaded by nonnative invasive plant species. An estimated 25,000 plant species have been brought into Florida for use as agricultural crops or landscape plants. While only a small number of these have become invasive, those that do can adversely affect native plant communities by competing for space and resources, disrupting hydrologic and fire regimes, or hybridizing with native species. They must be managed for the protection of native communities in natural areas. Chinese tallow (*Sapium sebiferum* L.) is one of these invasive plant species.

How to Recognize Chinese Tallow

Chinese tallow is a deciduous tree with a milky sap that commonly grows to 30 ft tall. Leaves are simple, alternate, 1–2.5 inches wide, with broadly rounded bases and tapering to a slender point (Figure 1). Leaf stalks are 1–2 inches long. Small yellow flowers that are borne on spikes to 8 inches long occur in spring (Figure 2). The fruit is a 0.5 inch wide, 3-lobed capsule that turns brown at maturity to reveal 3 dull white seeds (Figure 1). The seeds, which often remain attached to the tree through the winter, resemble popcorn, suggesting the other common name of popcorn tree.

Figure 1. Chinese tallow tree (*Sapium sebiferum* L.) can be identified by its simple, alternate leaves with broadly rounded bases that taper to a slender point and dull white seeds that remain attached after leaves have fallen.

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Figure 2. In spring, Chinese tallow tree displays spikes of small yellow flowers that are up to 8 inches in length.
Credits: Nancy J. Loewenstein, Auburn University

Distribution

Chinese tallow was introduced to the US before 1800. In a letter from Benjamin Franklin written in 1772 to Dr. Noble Wimberly Jones of the Georgia colony, Franklin wrote: "I send also a few seeds of the Chinese Tallow Tree, which will I believe grow & thrive with you. 'Tis a most useful plant" (Bell 1966). As early as 1803, Chinese tallow was spreading into coastal forests according to the noted French botanist Andre Michaux. Since Franklin's time, Chinese tallow has been introduced repeatedly to the United States as an ornamental and potential oil crop species. It is now naturalized from North Carolina, south through Central Florida, extending west into Texas and northwest Arkansas (McCormick 2005). Within Florida, Chinese tallow has increased greatly over the last twenty years. In 1993, it was naturalized in 57% of the counties (Jubinsky and Anderson 1996) and found as far south as Dade County (Wunderlin et al. 2003). Today, it is found in almost every county in the state.

Invasiveness

Chinese tallow has been recognized as a pest plant in the Carolinas since the 1970s (Langeland and Burks 1998). It is found throughout Florida where it invades mesic flatwoods, scrubby flatwoods, alluvial floodplain forest, strand swamp, and ruderal communities. Chinese tallow has been extensively used for ornamental planting and is a common plant on landscaped property. These trees present a constant source of seed for infestation of natural areas because the seeds are transported by birds such as pileated woodpeckers, cardinals, yellow-rumped warblers, American robins, and grackles, as well as by water (Jubinsky and Anderson 1996). While the length of time needed to deplete the seedbank is unknown, indications are that seeds remain viable for many years (Jubinsky and Anderson 1996). The Florida Exotic Pest Plant Council included Chinese tallow on its 1993 List of Florida's Most Invasive Species and it is currently a FLEPPC Category 1 species. **Chinese tallow was added to the Florida Department of Agriculture and Consumer Services Noxious Weed List (5b-57.007 FAC) in 1998. Plants on the Florida Noxious Weed List may not be introduced, possessed, moved, or released without a permit.**

Remove and Replace

Homeowners can help mitigate the problem of Chinese tallow trees in Florida's natural areas by removing them from their property. Mature trees should be felled with a chain saw by the property owner or a professional tree service. The final cut should be made as close to the ground as possible and as level as possible to facilitate application of an herbicide to prevent sprouting. Stumps that are not treated with an herbicide will sprout to form multiple-trunked trees (Figure 3). If it is not objectionable for dead trees to be left standing, certain herbicides can be applied directly to the bark at the base of the tree (basal bark application).

Figure 3. Stumps of felled Chinese tallow trees that are not treated with a herbicide will rapidly sprout to form multiple-trunked trees.

Herbicides that contain the active ingredient triclopyr amine (e.g., Brush-B-Gon, Garlon 3A) can be applied to cut stumps to prevent resprouting. The herbicide should be applied as soon as possible after felling the tree and concentrated on the thin layer of living tissue (cambium) that is just inside the bark. Herbicides with the active

ingredient triclopyr ester can be used for basal bark applications. Concentrated products (e.g., Garlon 4 Ultra) must be diluted, according to instructions on the herbicide label, with a penetrating oil, manufactured for this purpose. Herbicides with the active ingredients triclopyr ester can be used for basal bark applications. Herbicide products are available for basal bark application that are pre-diluted with penetrating oil (e.g., Pathfinder II). Only certain triclopyr amine products may be applied to trees that are growing in standing water. Suckers may grow from remaining roots, even if herbicide is applied to the parent tree. These suckers can be cut or treated with a foliar herbicide application. **It is illegal to use a herbicide in a manner inconsistent with the label's instructions; therefore, read the label carefully and follow the instructions.**

If trees are cut at a time when seeds are attached, make sure that the material is disposed of in such a way the seeds will not be dispersed to new areas where they can germinate and produce new trees. Seedlings should be pulled by hand before they reach seed-bearing maturity. A complete description of each of these control techniques can be found in the following publication: *Integrated Management of Nonnative Plants in Natural Areas of Florida*, K. A. Langeland, J. A. Ferrell, B. Sellers, G. E. MacDonald, and R. K. Stocker. 2011. http://edis.ifas.ufl.edu/wg209.

Space in a landscape left after removal of Chinese tallow can be used to plant a new native or noninvasive non-native tree for shade, or some other landscape purpose. Tree species recommended in Table 1 are similar in size to Chinese tallow. Blackgum, maples, dogwood, and crepe myrtles provide fall color similar to Chinese tallow. Fact sheets that provide additional information on landscape plants can be viewed at http://hort.ifas.ufl.edu/database/trees/trees_scientific.shtml. For information on the availability of native landscape plant species contact the Association of Florida Native Nurseries (877-352-2366 or http://www.afnn.org). The UF/IFAS Extension office in your county can help you identify plants appropriate to your property conditions, the ecosystems on and near your site, and your aesthetic preferences.

Table 1. Some suggested tree species for replacing Chinese tallow.

Native	Florida Hardiness Zones
American Hornbeam (*Carpinus caroliniana*)	North, Central
Blackgum (*Nyssa sylvatica* var. *sylvatica*)	North, Central
Cedar Elm (*Ulmus crassifolia*)	North, Central
Eastern Hophornbeam (*Ostrya virginiana*)	North, Central
Eastern Redbud (*Cercis canadensis*)	North, Central
Flatwoods Plum (*Prunus umbellata*)	North, Central
Florida Maple (*Acer saccharum* ssp. *floridanum*)	North, Central
Flowering Dogwood (*Cornus floridana*)	North, Central
Fringe Tree (*Chionanthus virginicus*)	North, Central
Geiger Tree (*Cordia sebestena*)	South
Paradise Tree (*Simarouba glauca*)	South
Red Bay (*Persea barbonia*)	Throughout
Red Maple (*Acer rubrum*)	Throughout
Red Stopper (*Eugenia confusa*)	South
River Birch (*Betula nigra*)	North, Central
Satin Leaf (*Chrysophyllum oliviforme*)	South
Silverbell (*Halesia diptera*)	North, Central
Swamp Bay (*Persea palustris*)	Throughout
Turkey Oak (*Quercus laevis*)	North, Central
White Ash (*Fraxinus americana*)	North
Winged Elm (*Ulmus alata*)	North, Central
Non-native	
Crepe Myrtle (*Lagerstroemia indica*)	Throughout
Queens Crepe Myrtle (*Lagerstroemia speciosa*)	South
Trumpet Tree (*Tabebuia argentea*)	South

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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 nd 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.

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Introduced and Invasive Species in Florida — Online Resources

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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.

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

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/

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- 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

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

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. 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/stopping-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.

NOTES

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