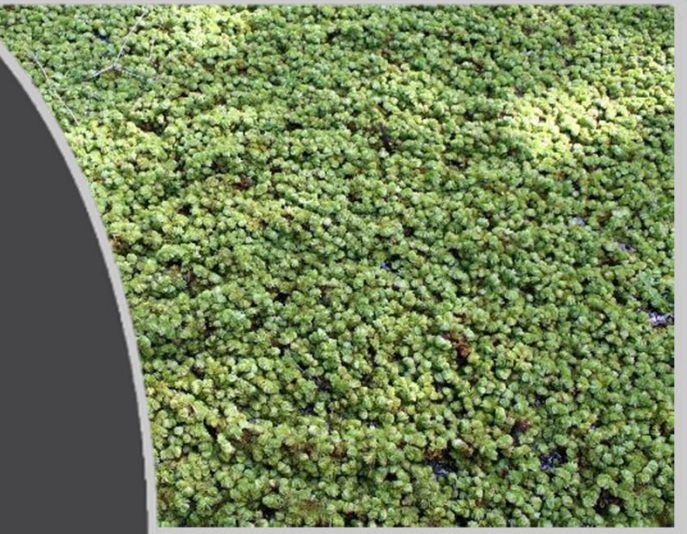
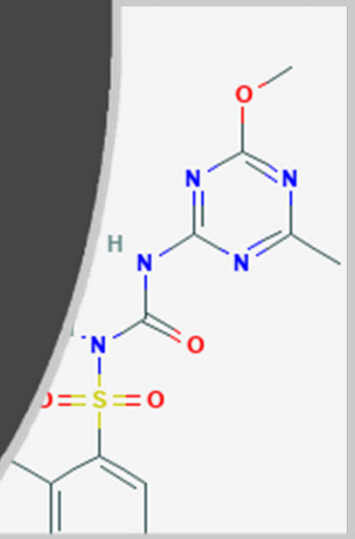
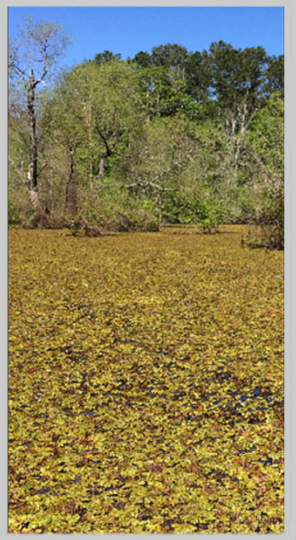
# Chemical Control of Giant Salvinia: Updates and Challenges







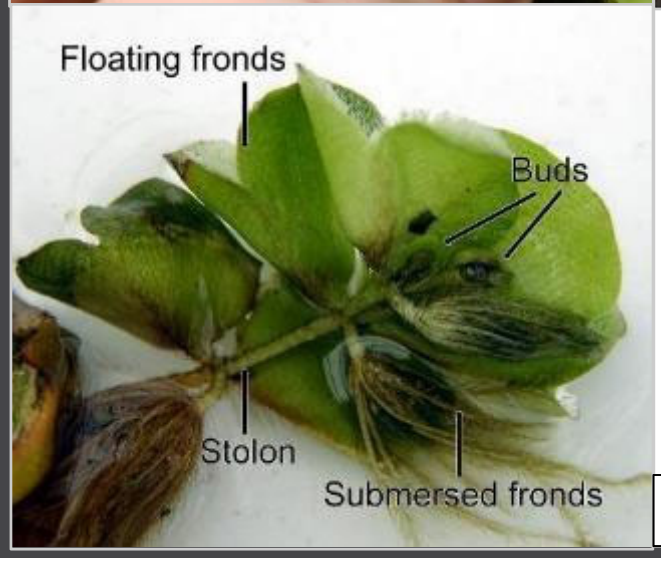

- **Christopher R. Mudge, Ph.D.**
  - *Research Biologist – U.S. Army Engineer Research & Development Center, Environmental Laboratory, Baton Rouge, LA*
  - *Adjunct Professor – LSU School of Plant, Environmental & Soil Sciences*

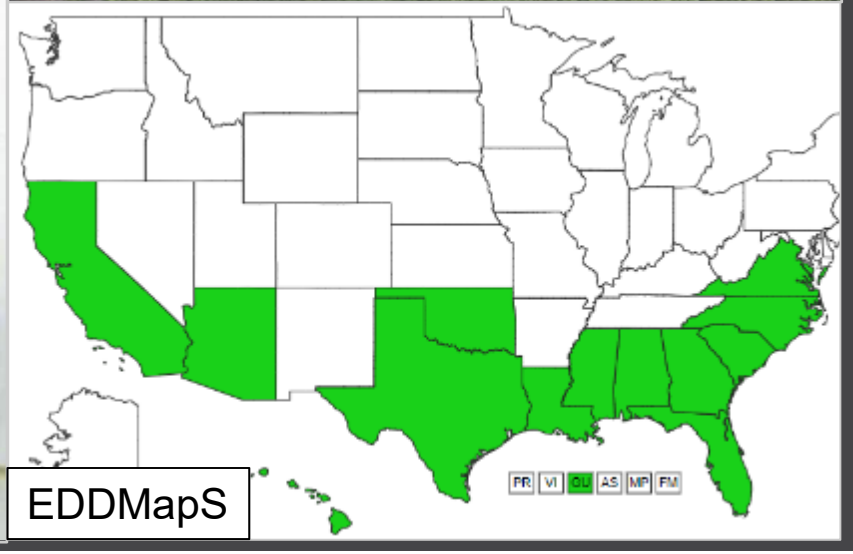

ISLT/APMS Webinar Oct 2020

US Army Corps of Engineers

ERDC

# Giant Salvinia – *Salvinia molesta*



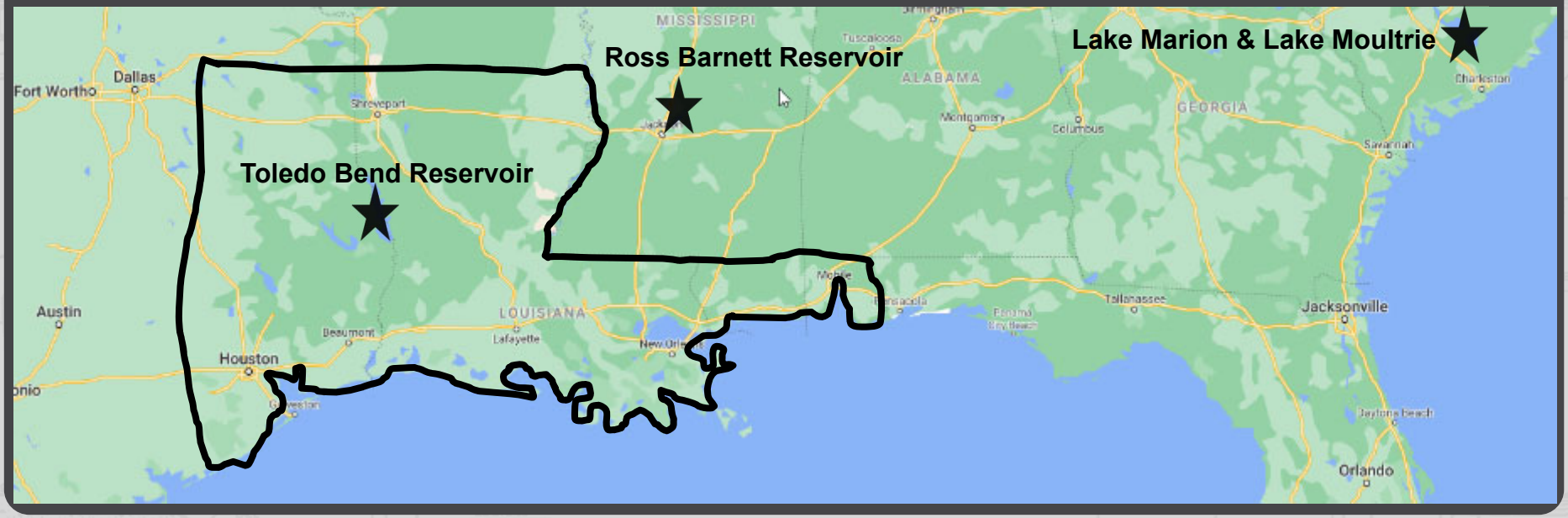



# Giant Salvinia Characteristics

- Free floating sterile aquatic fern native to Brazil
- Emergent fronds with fused trichomes
- Submersed fronds, root-like
- Explosive growth rate
- Mats up to 1 meter thick (several plant layers)

# Major Giant Salvinia Infestations in S.E. U.S.

- Louisiana: most water bodies
- Texas: eastern portion of state
- Mississippi: Ross Barnett and towards coast
- South Carolina: Santee Cooper system (Lake Marion & Lake Moultrie)



# Giant Salvinia Challenges

- **Budgets: limited state/Federal funds and yearly cuts (Covid-19)**
- **Limited efficacious herbicides**
- **Water: 17% of LA, continuous & nutrient rich**
- **Heavily forested man-made waterbodies**
  - **Impounded swamps that harbor plants**
- **Winter conditions**
  - **Mild to moderate: minimal plant die-off**
  - **Severe: weevil mortality (especially northern LA/TX)**
- **Public perception: too little or too much efforts**

# Giant Salvinia Herbicide Management

- **Growing Season: ~March to November**
  - **Foliar application**
    - **Glyphosate**
    - **Glyphosate + diquat/flumioxazin/carfentrazone**
    - **Penoxsulam + carfentrazone/flumioxazin**
    - **Metsulfuron (LA/TX/SC only)**
  - **Subsurface application**
    - **Penoxsulam**
    - **Fluridone**


- **Winter: ~December to February**
  - **Foliar application**
    - **Diquat**
    - **Flumioxazin**

# Aquatic Herbicide Use & Limitations

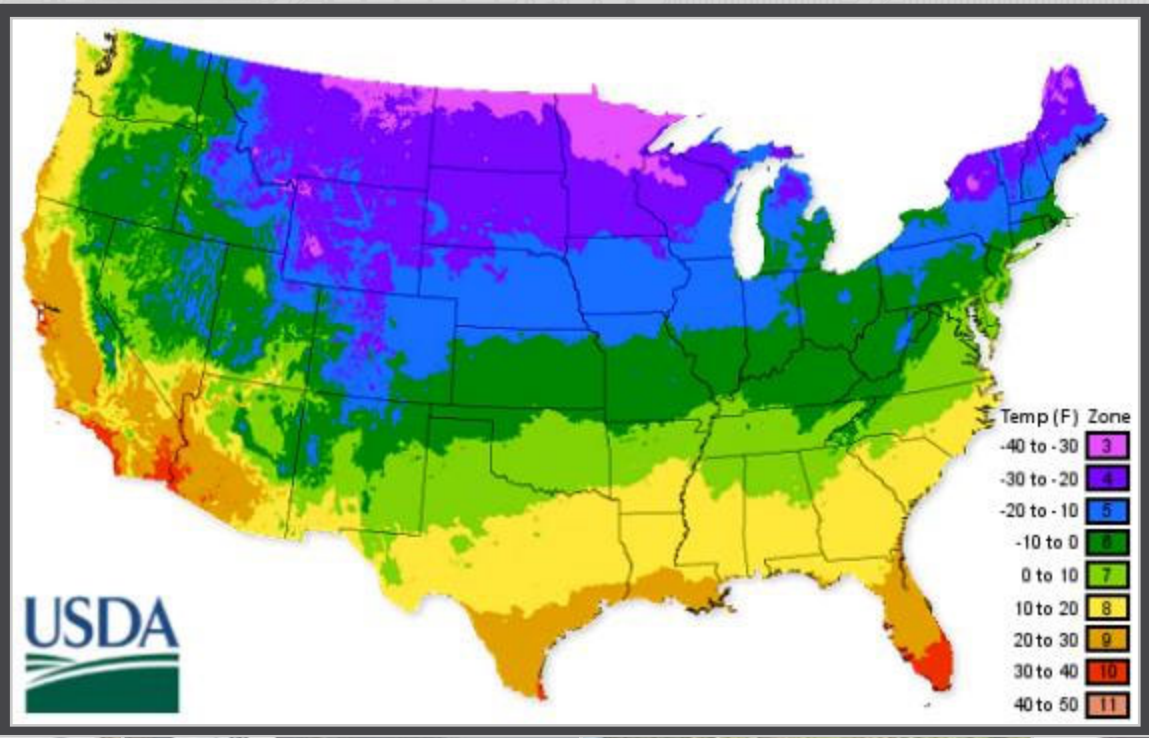
- **Foliar applications**
  - Slow to rapid control when contact achieved
  - Failure to achieve complete control of surface matted populations (2+ layers thick) and repeat treatments could be required
- **Subsurface applications**
  - Slow control & complete plant exposure
  - Difficulty in meeting exposure time requirements (10+ weeks) and cost prohibitive in large systems

# Winter Weed Management

- Not widely accepted, used, or necessary
  - Downtime for resource managers and spray crews
- Maintenance control for daily spraying of low volumes of herbicides
  - Louisiana – giant salvinia and water hyacinth
  - Florida – water hyacinth, SAVs, emergent spp., etc.

# Temperature and Hardiness Zones


- Typical freeze and frost conditions in Louisiana
  - Coastal: minimal
  - South: mild
  - Central: mild to moderate
  - North: moderate to severe


USDA
Temp (F) Zone
-40 to -30 3
-30 to -20 4
-20 to -10 5
-10 to 0 6
0 to 10 7
10 to 20 8
20 to 30 9
30 to 40 10
40 to 50 11

# Winter Plant Conditions in North LA

# South LA – Chalmette January 2014

# South LA – Chalmette July 2014

## Normal/Cold Winter

- Best case
- 1 plant layer early in growing season
- Minimal plants at end of growing season
- Spray and get control

## Mild/Non-existent Winter

- Worst case
- Plant stand >3 layers
- Substantial winter carryover
- Spray but recovery

# Hiding Places and Shelters

# Plant Control in Winter?

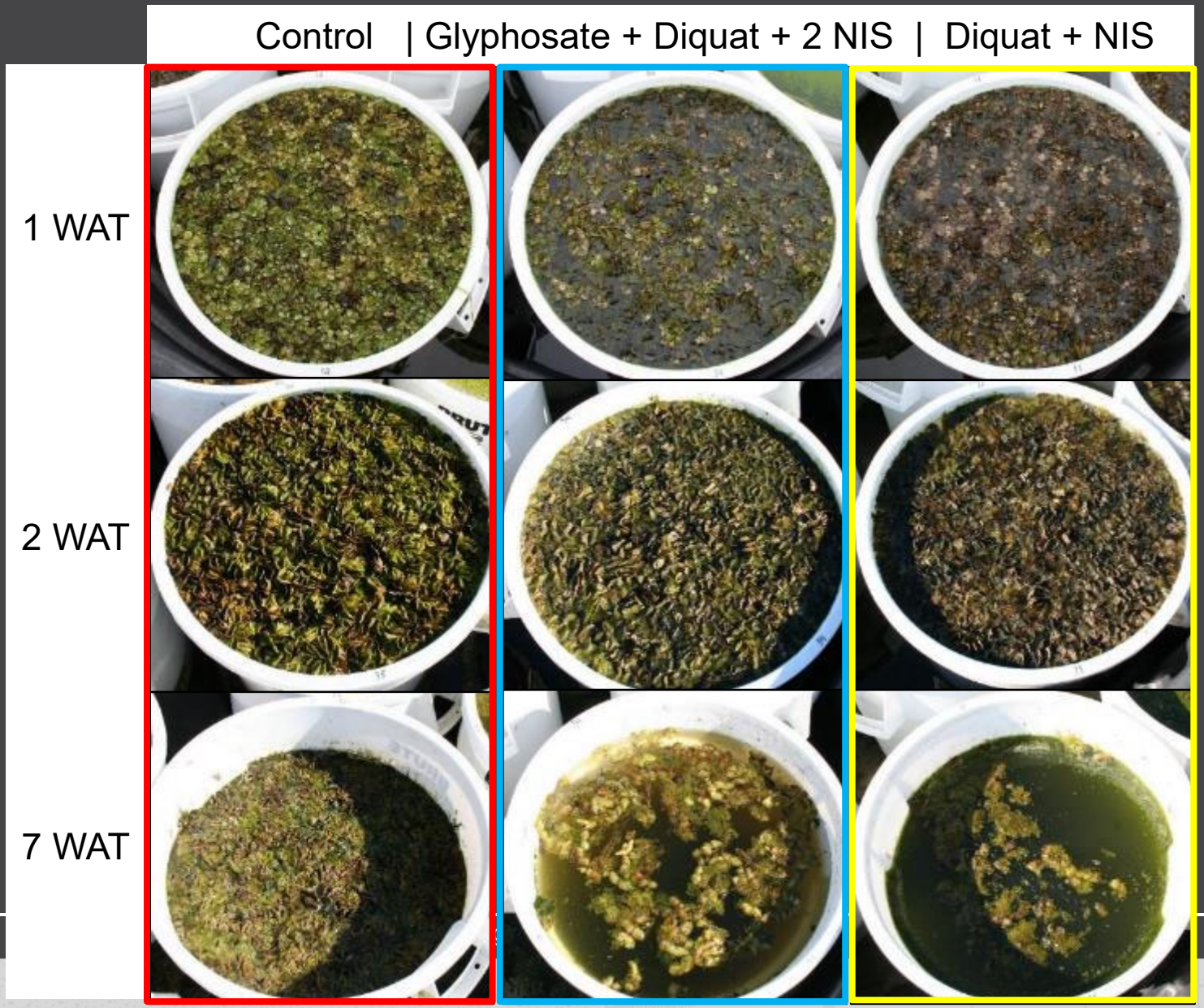
- Control of slow growing plants under cool/cold conditions?
- Plant response to herbicide application prior to and after freeze/frost events?
- Systemic vs contact herbicides?

# Winter Herbicide Trials

| Herbicide Treatment | Rate (oz/A) |
|---|---|
| Control | 0 |
| Glyphosate + Diquat + NISBA + NIOS | 96 + 32 + 32 + 12 |
| Glyphosate + Flumioxazin + MVO | 96 + 2 + 32 |
| Glyphosate + Carfentrazone + MVO | 96 + 4 + 32 |
| Endothall + Flumioxazin | 16 + 4 + 32 |
| Diquat + MVO | 96 + 32 |
| Diquat + NIS | 96 + 32 |
| Glyphosate + MVO | 120 + 32 |

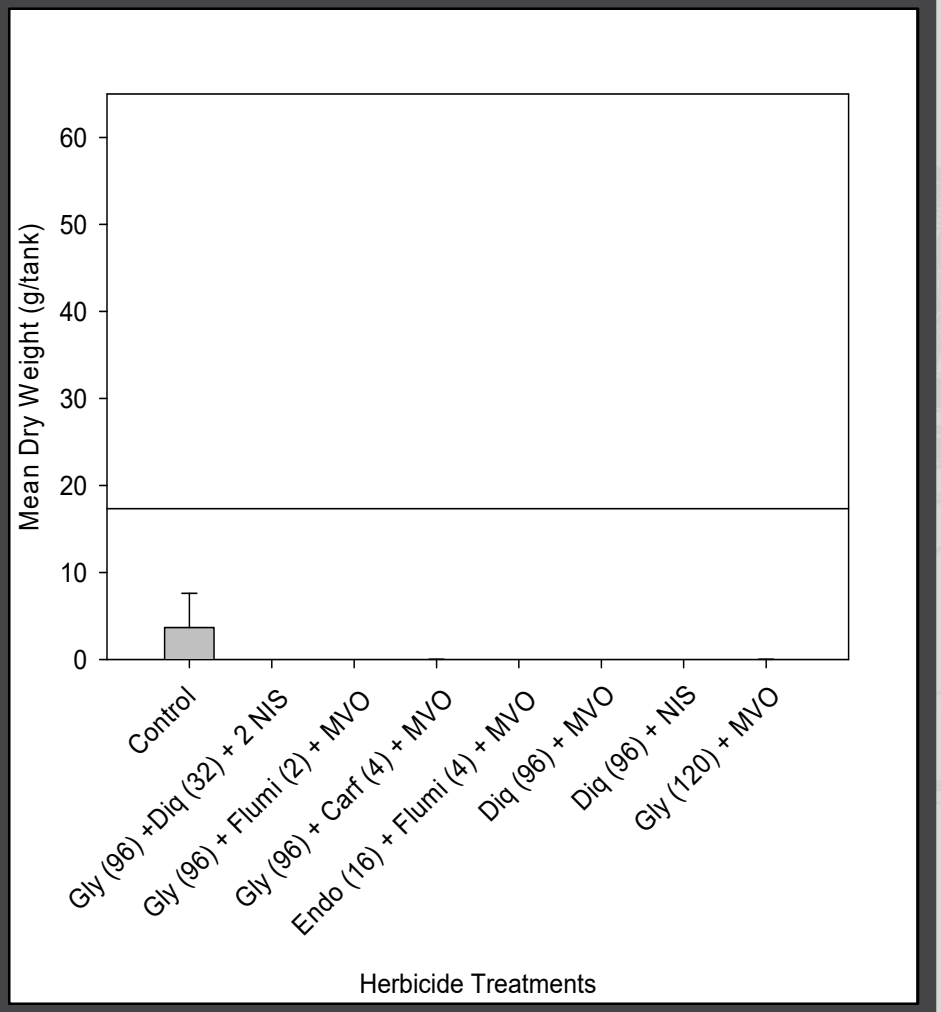
| Trial | Year | Winter | Plants Covered | Winter Simulation |
|---|---|---|---|---|
| 1 | 2014-2015 | Severe | No | Open water with freeze |
| 2 | 2015-2016 | Mild | No | Open water with frost |
| 3 | 2015-2016 | Mild | Yes | Plants protected by canopy |

# Uncovered Severe Winter Trial – 7 WAT

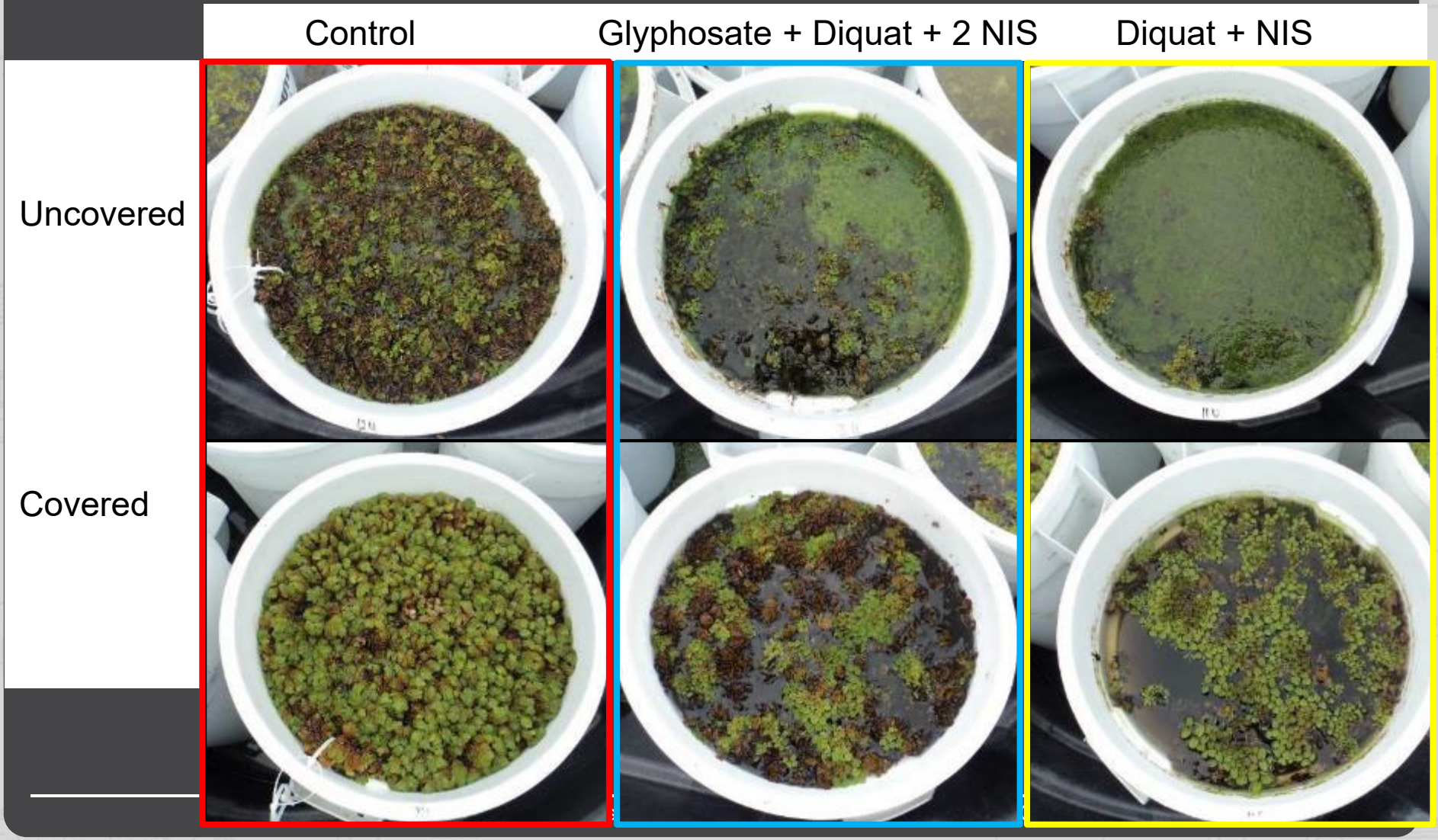


# Uncovered Severe Winter Trial – 7 WAT

- Injury 1 to 5 days after treatment (DAT)
- <32ºF for 5 hr (14 DAT)
- ≤32ºF for 40 hr (throughout)
- 99.7 to 100% control
- Journal of Aquatic Plant Management (2018) 56:68-71

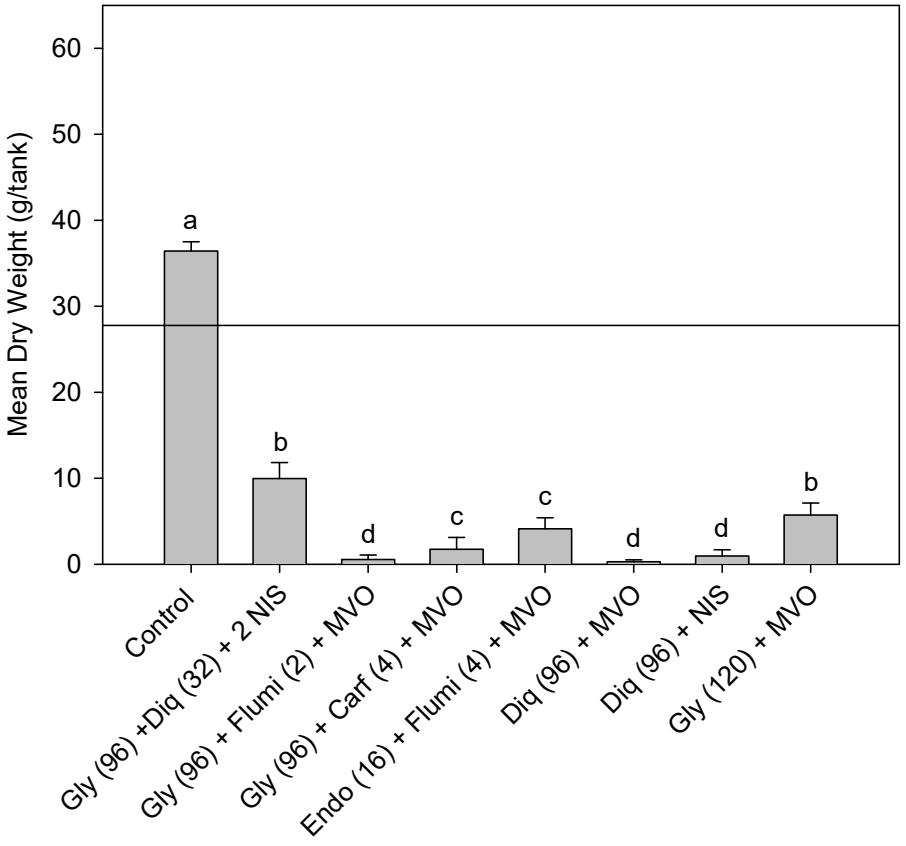


# Mild Winter Trials – 15 WAT



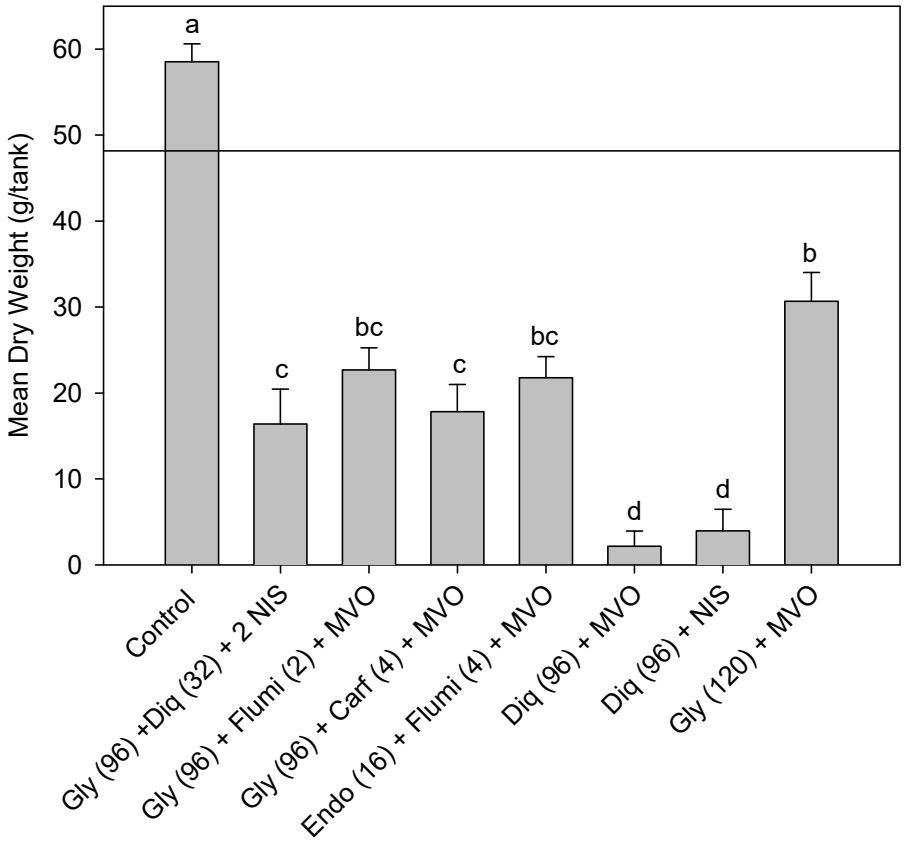
# Mild Winter Trials – 15 WAT

## Uncovered




72 to 99% control

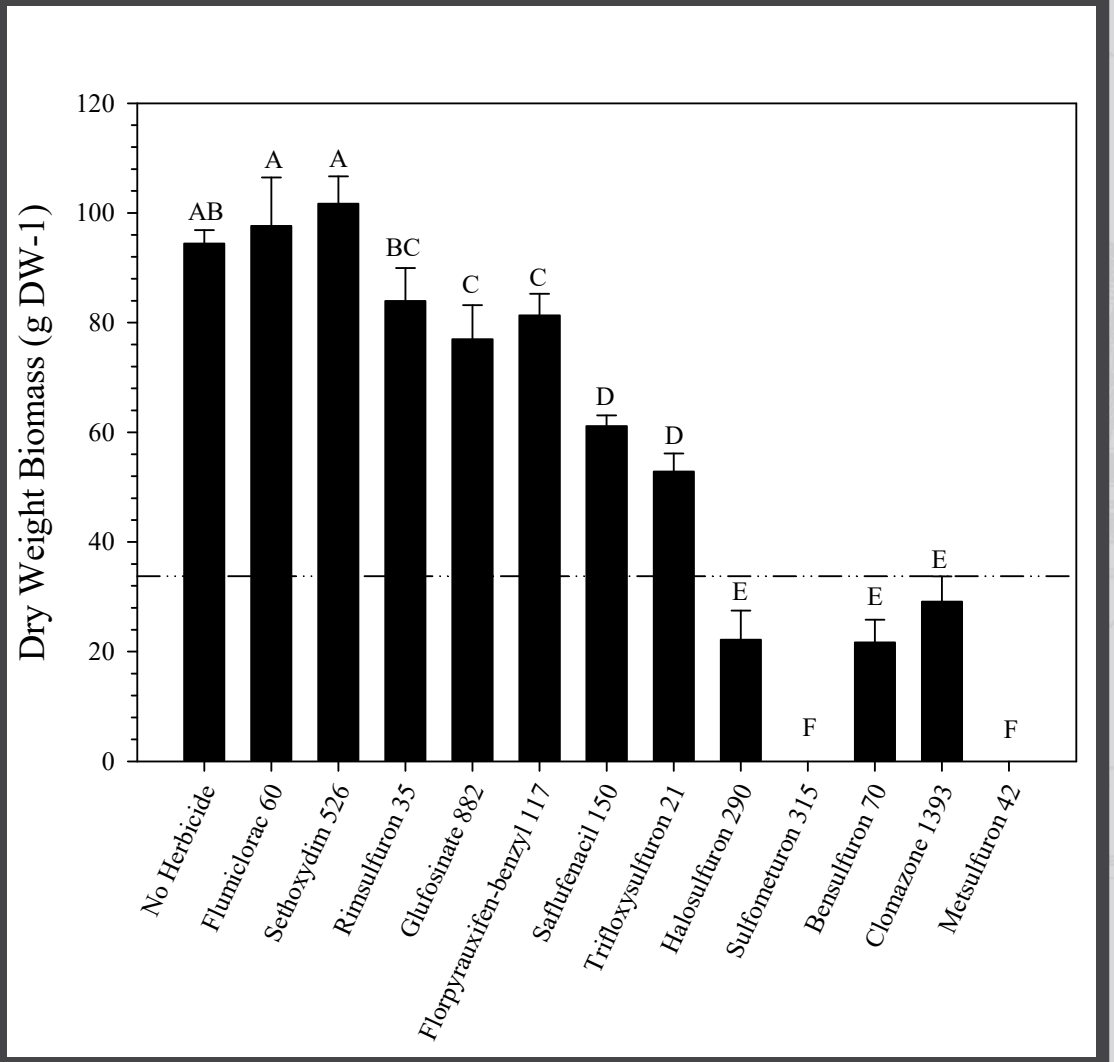
## Covered




47 to 96% control

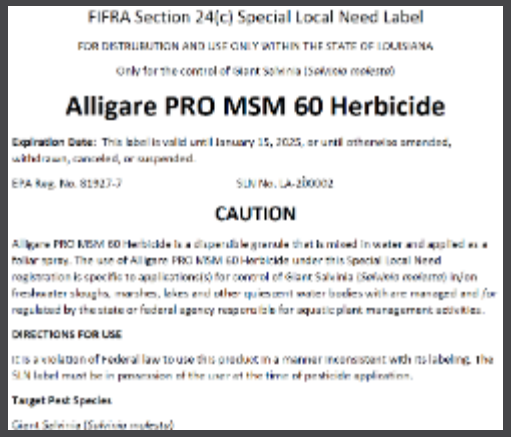
# Giant Salvinia Herbicide Screening

- Screened 12 non-aquatic herbicides registered for use in turf, right-of way, row crops, etc.
- Herbicides applied at max labeled rate
- Metsulfuron and sulfometuron provided 98 to 100% control in 2 trials
- Dr. Bradley Sartain Dissertation & Journal of Aquatic Plant Management (2018) 56:107-112



# Metsulfuron-methyl Giant Salvinia SLN

- 2019 and 2020: 4 Special Local Need Labels
  - Alligare: PRO MSM 60 (LA & TX)
  - Bayer: Cimarron Max Part A (LA & SC)
- Where to use: <u>public waterways</u>
  - Freshwater systems
  - <u>No private land use</u>
- Who can use/apply it
  - <u>State/Federal agencies & hired contractors</u>
- Rate: <u>0.5 to 1 oz/A (per year)</u>
  - No repeat applications



FIFRA Section 24(c) Special Local Need Label

FOR DISTRIBUTION AND USE ONLY WITHIN THE STATE OF LOUISIANA

Only for the control of Giant Salvinia (*Salvinia molesta*)

**Alligare PRO MSM 60 Herbicide**

**Expiration Date:** This label is valid until January 15, 2025, or until otherwise amended, withdrawn, canceled, or suspended.

EPA Reg. No. 81927-7 SLN No. LA-200002

**CAUTION**

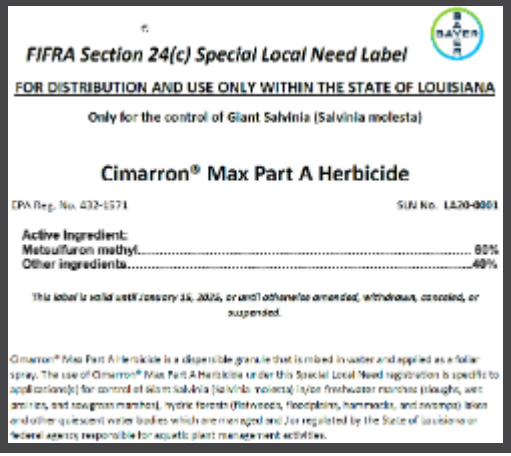
Alligare PRO MSM 60 Herbicide is a dispersible granule that is mixed in water and applied as a foliar spray. The use of Alligare PRO MSM 60 Herbicide under this Special Local Need registration is specific to application(s) for control of Giant Salvinia (*Salvinia molesta*) in/on freshwater sloughs, marshes, lakes and other quiescent water bodies which are managed and /or regulated by the state or federal agency responsible for aquatic plant management activities.

**DIRECTIONS FOR USE**

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. The SLN label must be in possession of the user at the time of pesticide application.

**Target Pest Species**

Giant Salvinia (*Salvinia molesta*)



*FIFRA Section 24(c) Special Local Need Label*

FOR DISTRIBUTION AND USE ONLY WITHIN THE STATE OF LOUISIANA

Only for the control of Giant Salvinia (*Salvinia molesta*)

**Cimarron® Max Part A Herbicide**

EPA Reg. No. 432-1571 SLN No. LA20-0001

**Active Ingredient:**
Metsulfuron methyl..... 60%
Other ingredients..... 40%

*This label is valid until January 15, 2025, or until otherwise amended, withdrawn, canceled, or suspended.*

Cimarron® Max Part A Herbicide is a dispersible granule that is mixed in water and applied as a foliar spray. The use of Cimarron® Max Part A Herbicide under this Special Local Need registration is specific to application(s) for control of Giant Salvinia (*Salvinia molesta*) in/on freshwater marshes (sloughs, wet prairies, and seasonal marshes), hydric forests (flatwoods, floodplains, hammocks, and swamps), lakes and other quiescent water bodies which are managed and /or regulated by the State of Louisiana or federal agency responsible for aquatic plant management activities.

# Metsulfuron Foliar Trial – 2 WAT

Control

0.0625 oz/A
(2.6 g a.i./ha)

0.125 oz/A
(5.3 g a.i./ha)

0.25 oz/A
(10.5 g a.i./ha)

0.5 oz/A
(21.1 g a.i./ha)

1 oz/A
(42.1 g a.i./ha)

2 oz/A
(84.1 g a.i./ha)

4 oz/A
168.2 g a.i./ha

## William Prevost Thesis Research (LSU 2018-2019)

# Metsulfuron Foliar Trial – 2 WAT

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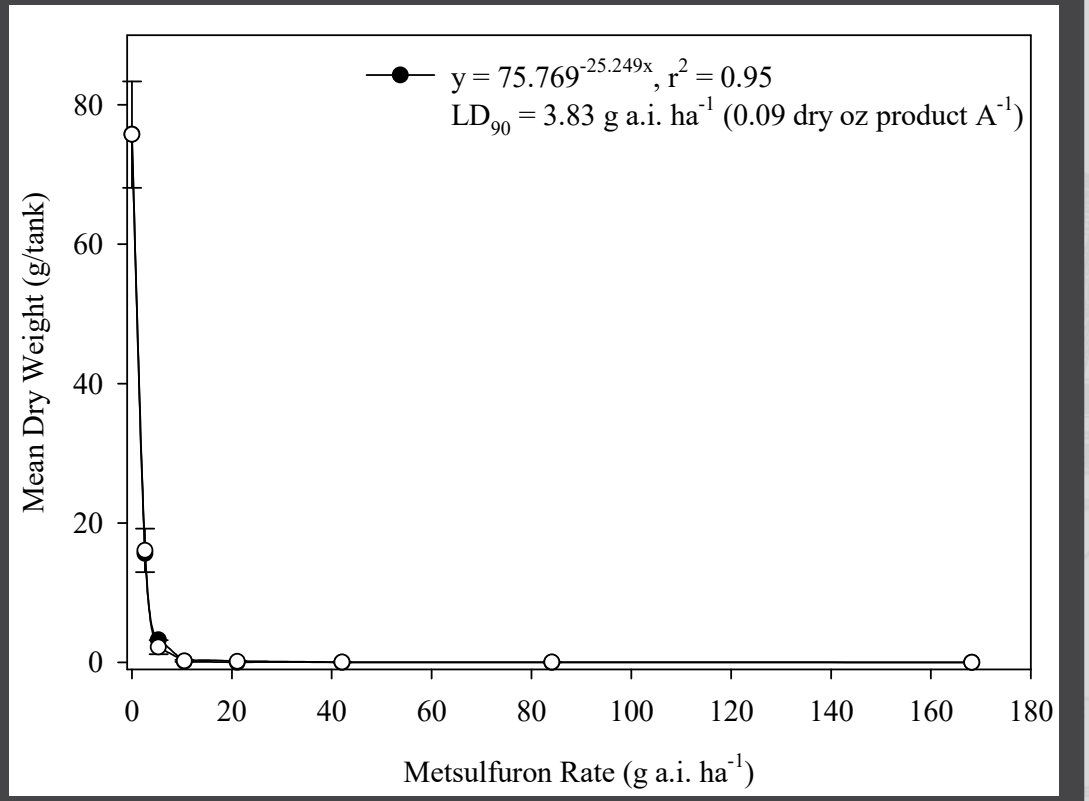
4 oz/A
(168.2 g a.i./ha)

## William Prevost Thesis Research (LSU 2018-2019)

# Metsulfuron Foliar Trial – 8 WAT

- Plants recovered from 0.065 and 0.125 oz/A treatments
- Dry weight reduced 94 to 100% at rates ≥ 0.125 oz/A
- $LD_{90}$ = 0.09 oz/A
- William Prevost Thesis Research (LSU 2018-2019) & J. Aquatic Plant Management (2021)



# Metsulfuron Foliar Combination – 2 WAT


Control


Metsulfuron


Glyphosate + Diquat


Glyphosate + Flumioxazin


Metsulfuron + Glyphosate


Metsulfuron + Diquat

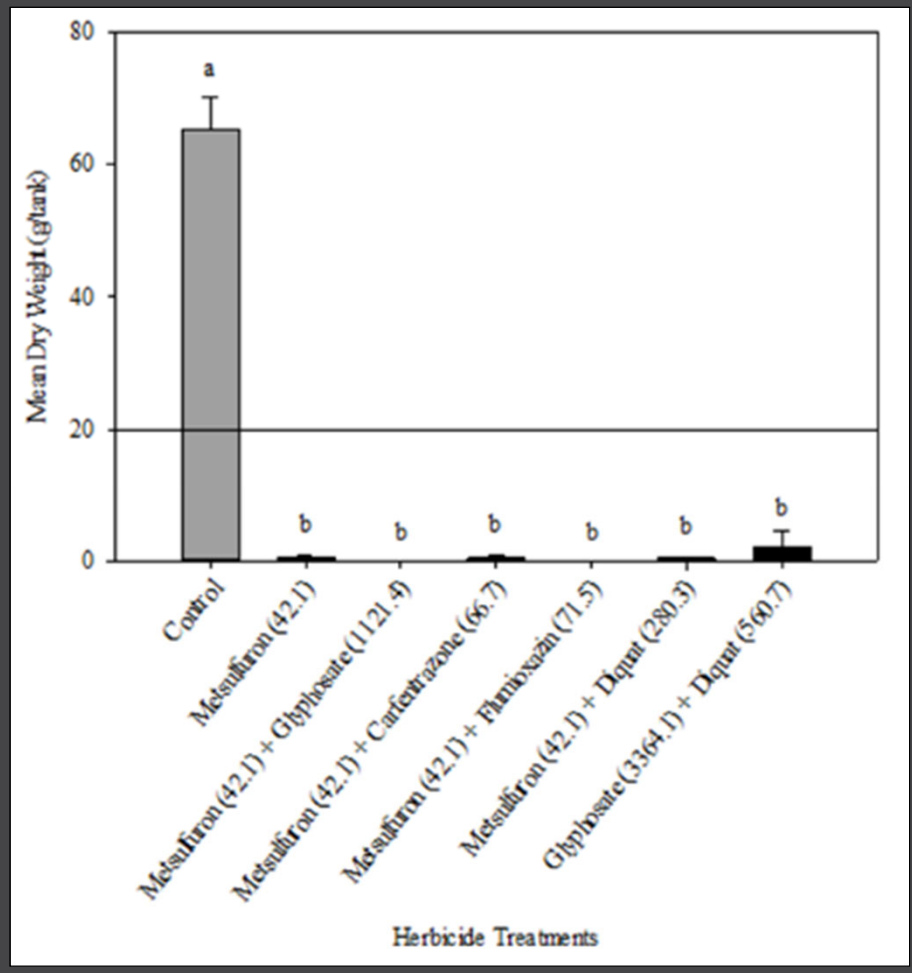

Metsulfuron + Flumioxazin


Metsulfuron + Carfentrazone

## William Prevost Thesis Research (LSU 2018-2019)

# Metsulfuron Foliar Combination – 8 WAT

- Metsulfuron compatible with all tank mix partners
- ≥ 98% giant salvinia control with metsulfuron alone and combination treatments
- Slower injury and control with metsulfuron alone
- William Prevost Thesis Research (LSU 2018-2019) & J. Aquatic Plant Management (2021)

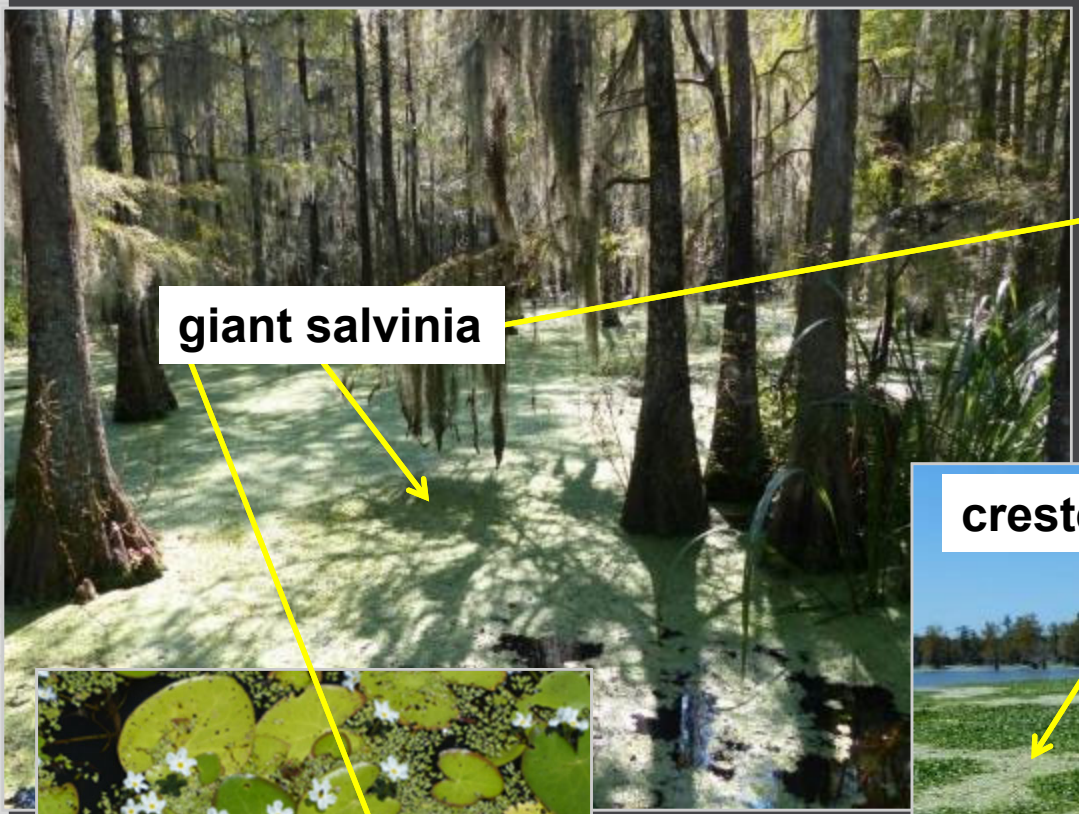


# Lake Marion & Lake Moultrie, SC

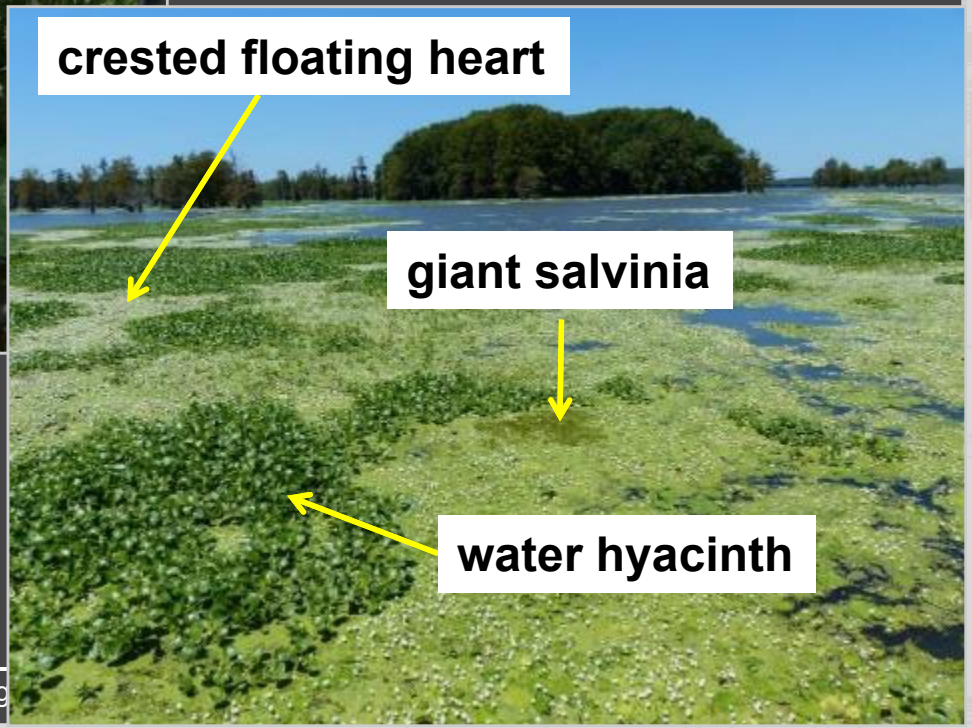
- Discovered in July 2017
- Hydroelectric system of 2 lakes operated by Santee Cooper

| Species | 2017 Acres Treated | 2019 Acres Treated |
|---|---|---|
| Crested Floating Heart | 467.35 | 701 |
| Water Hyacinth | 245.5 | 117 |
| Giant Salvinia | 5.5 | 594 |


# Mixed Weed Populations in SC




All Photos:
Casey Moorer



# Treatments Evaluated by Santee Cooper

- Giant salvinia
  - Diquat + flumioxazin
  - Penoxsulam + carfentrazone
  - Glyphosate + carfentrazone
  - Salvinia weevils
- Mixed giant salvinia and crested floating heart
  - Diquat
  - Fluridone
  - Endothall (dipotassium salt)
  - Flumioxazin + imazamox
- Mixed giant salvinia and giant cutgrass
  - Glyphosate + imazapyr

# Santee Copper – Fluridone 30 ppb

All Photos: Casey Moorer

# Ross Barnett Reservoir

- Water drinking supply for Jackson, MS
- Giant Salvinia discovered in June 2018 in Pelahatchie Bay
- Pearl River Valley Water Supply District, MS Department of Wildlife, Fisheries and Parks, Mississippi State, & ERDC
- Management: containment (booms), boat/aerial herbicide applications, herb. mixes, drawdowns, surveys desiccation, controlled burns, cold weather, close boat ramps, etc.





All Photos: Ryan Jones

# RBR – Containment Booms & Drawdown

All Photos: Ryan Jones

# RBR – Controlled Burn

Ryan Jones

# RBR – Cut & Removal of Buttonbush

US Army Corps of Engine

All Photos: Ryan Jones

# Current Status of Ross Barnett Reservoir

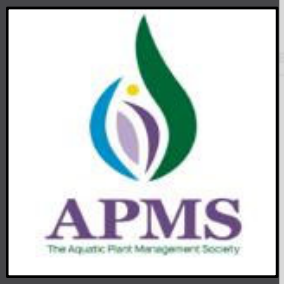
- No healthy giant salvinia observed
- Recommend fall drawdown
- Continue intensive surveys
- Education
- Clean drain dry campaign
  - Signs/handouts at every ramp
  - Television air-time
  - Cleaning stations
- Contain spreading
- Treat aggressively
- Monitor the range

# Acknowledgements


- ERDC Invasive Species Leadership Team
- Aquatic Plant Management Society
- ERDC: APCRP, Dr. Bradley Sartain and William Prevost
- LSU AgCenter: Faculty, staff, and student workers
- Louisiana Department of Wildlife & Fisheries: APCP, Daniel Hill, Jonathan Winslow, and Alex Perret
- Santee Cooper: Casey Moorer
- MS Depart. of Wildlife, Fisheries and Parks: Ryan Jones
- Mississippi State University: Gray Turnage







# GIANT SALVINIA BIOCONTROL AGENT REARING, RELEASE, AND FIELD ESTABLISHMENT

**Prepared by Julie Nachtrieb**
**US Army ERDC, Lewisville Aquatic Ecosystem Research Facility**

**Invasive Species Fall Webinar Series**

**21 October 2020**

US Army Corps of Engineers

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

# Biological Control of Giant Salvinia

- Salvinia weevil (*Cyrtobagous salviniae*)
  - Host-specific biological control agent
  - Adult stage
    - Feed on buds and leaves
      - Cause salvinia growth suppression
  - Larval stage
    - Tunnel within rhizome
      - Disrupt nutrient flow
  - Successful at managing giant salvinia in 13 countries worldwide
  - Low success in temperate U.S. regions
    - Primarily due to unsuccessful weevil overwintering

# ERDC Giant Salvinia Biocontrol

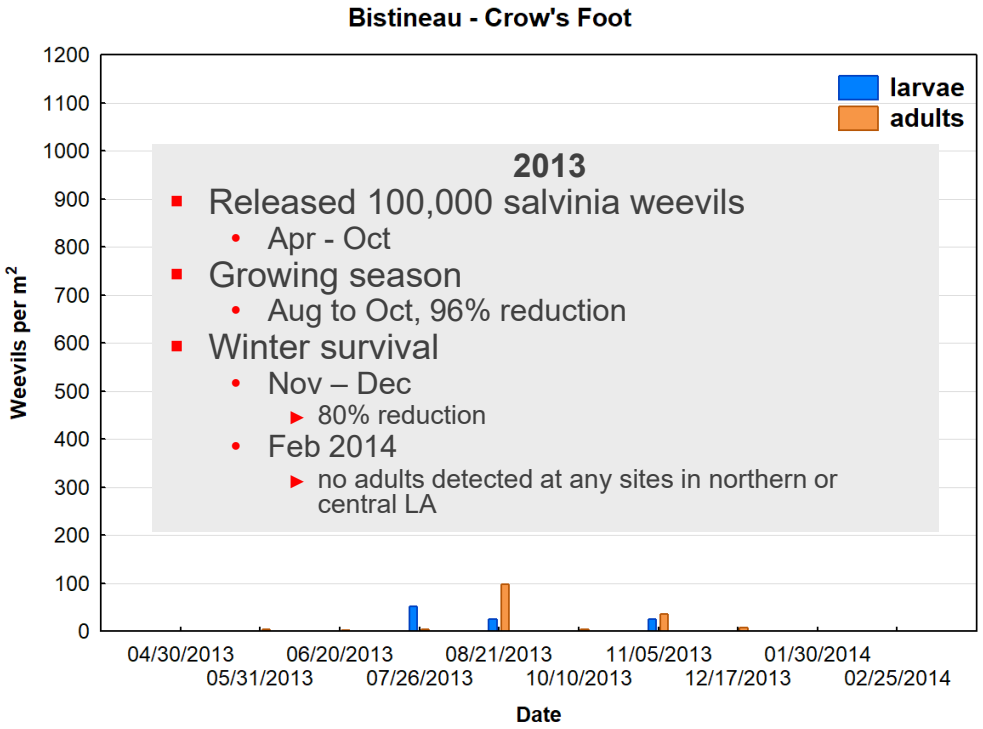
- Weevil rearing
  - Conducted at LAERF in TX
  - Began in ponds in 2003
    - Inconsistent overwintering
  - Converted to cold frames in 2008
- Rearing, release, and monitoring efforts
  - Expanded in 2012
    - Multiple waterbodies
      - North to south LA
        - » LDWF waterbodies
      - Southeast TX
        - » USACE Reservoirs Steinhagen & Rayburn
    - Large-scale field releases
    - Year-long sampling at 4-6 week intervals

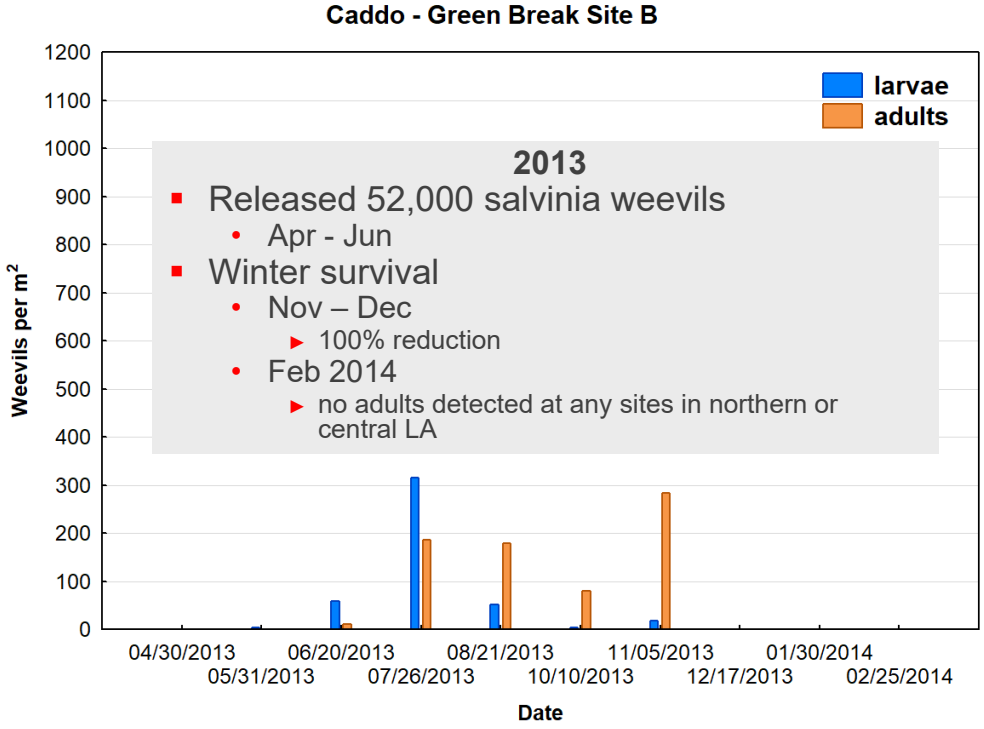
# Insect Field Establishment & Plant Management

- Step 1 – Insect Field Establishment
  - Insect presence & population growth
    - ▸Short term – 1 growing season
    - ▸Long term – multiple growing season
      - – Successful overwintering
- Step 2 – Plant Management
  - Decreased plant health
    - ▸Size, density, reproduction

- Variable weevil establishment & population growth
  - Site specific differences
  - What is limiting success?
    - ▸Temperature extremes
    - ▸Plant nutritional quality or nitrogen content

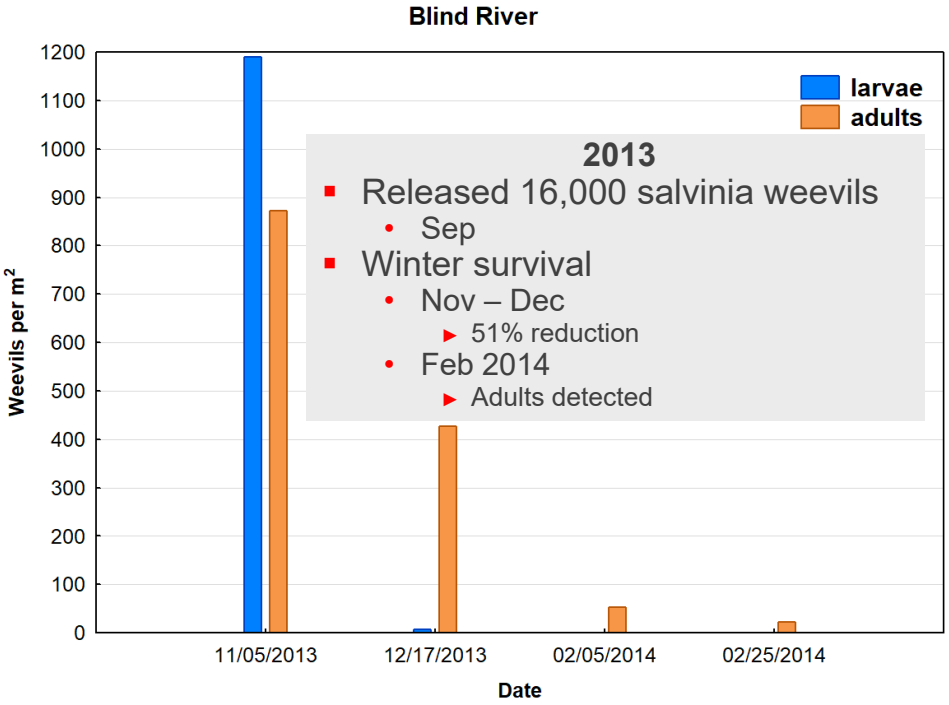

# Temperature Extremes, Northern Louisiana

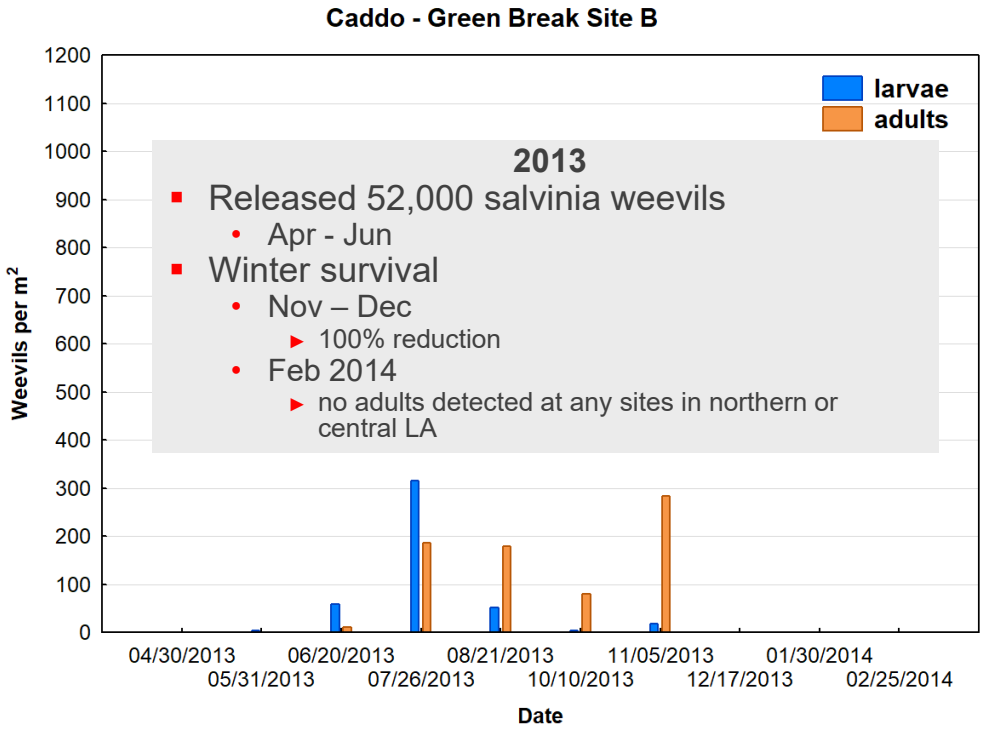



- Bistineau
  - 32.44°N 93.39°W
- Caddo
  - 32.71°N 94.02°W

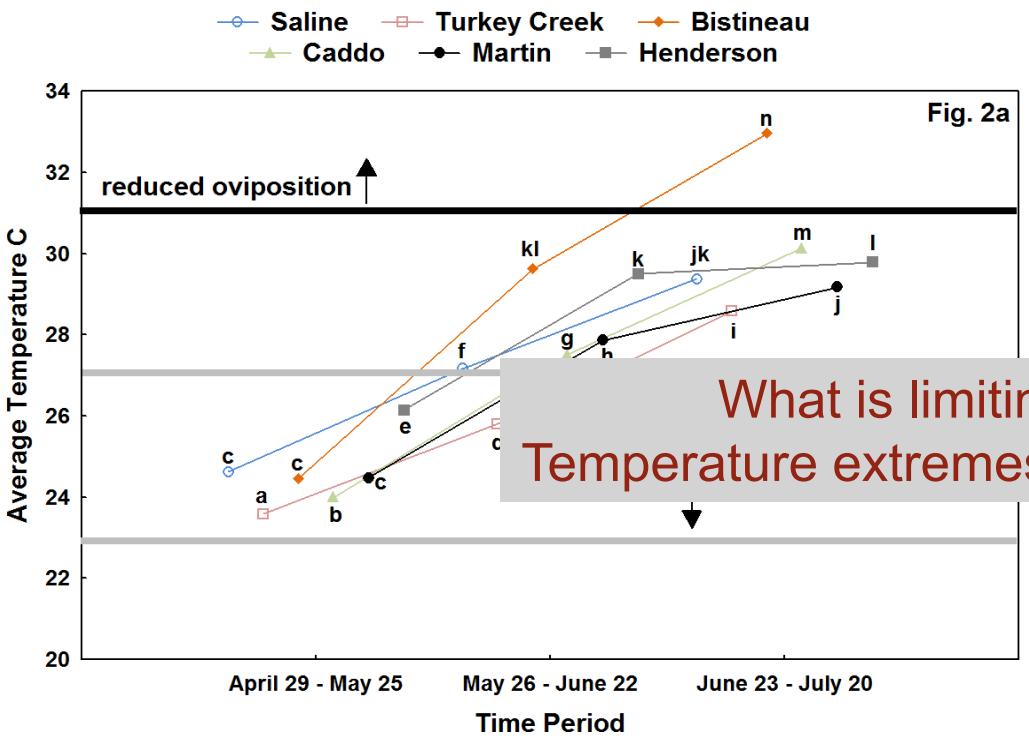
# Temperature Extremes, Northern Louisiana

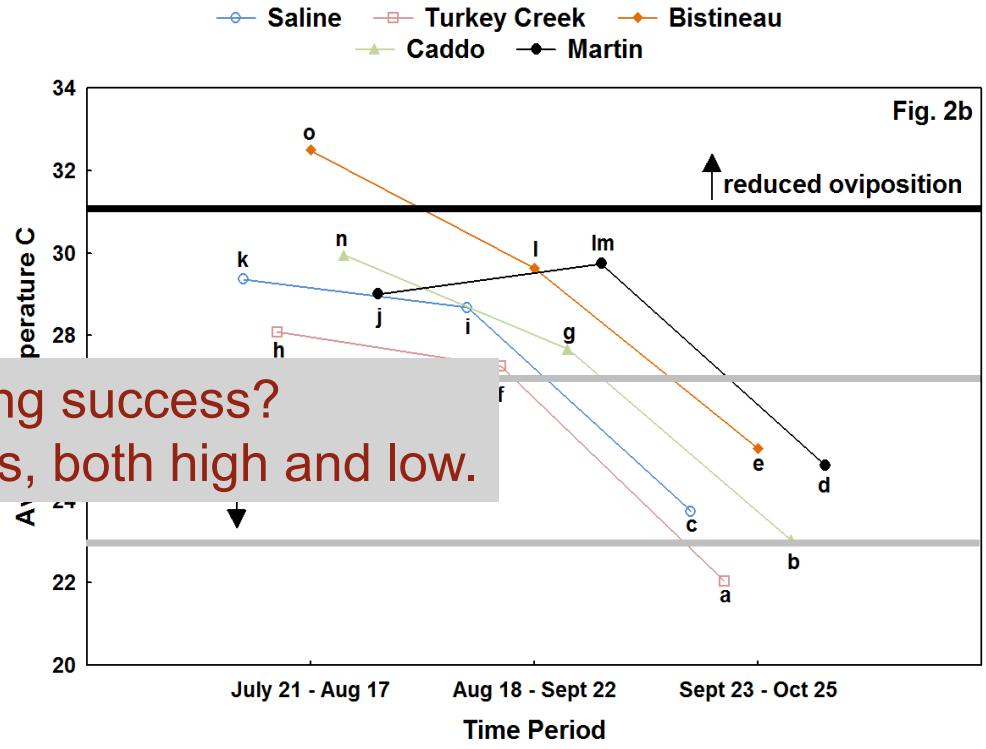



- Blind River
  - 30.16°N 90.70°W
- Caddo
  - 32.71°N 94.02°W

# Temperature Extremes, Northern Louisiana



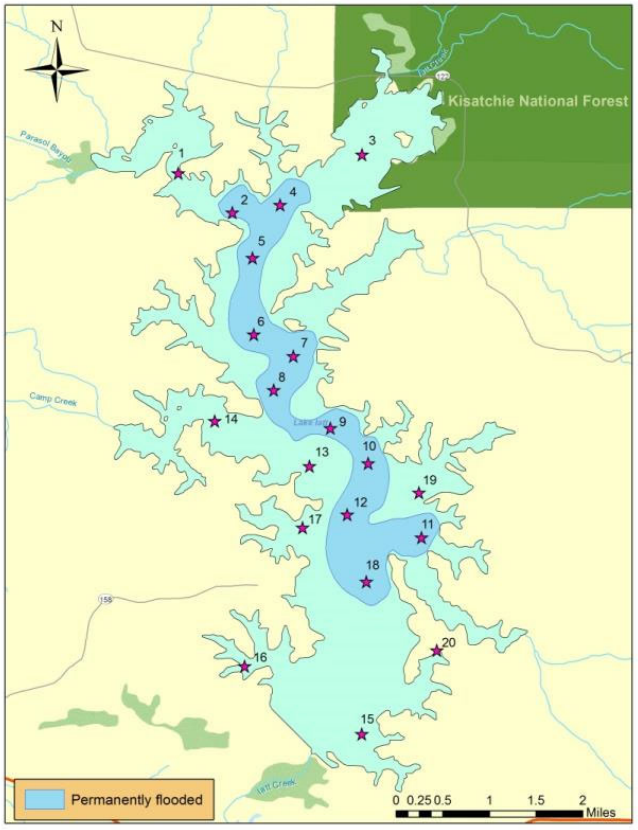




What is limiting success?
Temperature extremes, both high and low.

# Established & Self-sustaining Weevils, Central Louisiana

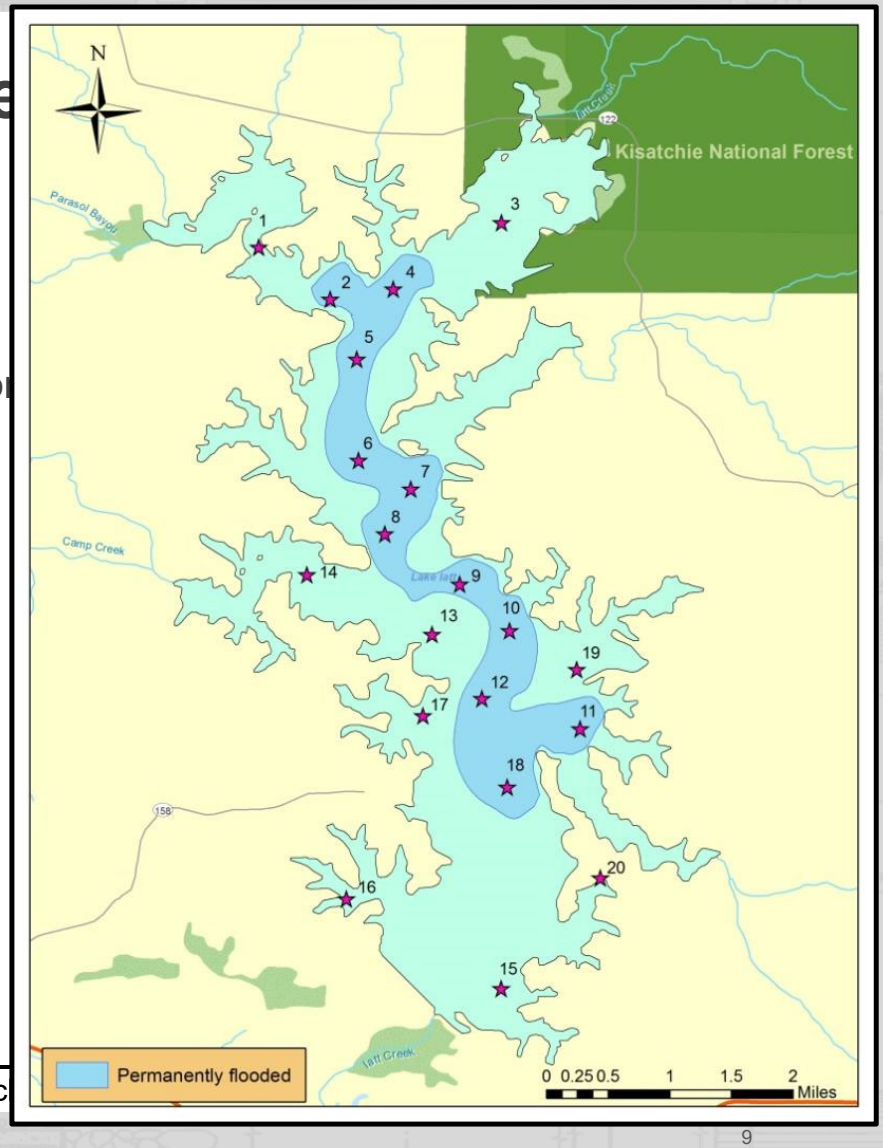
- Lake Iatt
  - Central Louisiana
    - 31.58°N  92.65°W
  - 6,600 acres
  - Yearly water level drawdowns
    - Private timber harvesting
    - Giant salvinia management

- Salvinia weevils
  - Summer 2015
    - 150,000 weevils released
  - Feb 2017 – weevils lake-wide
    - Large-scale monitoring efforts initiated



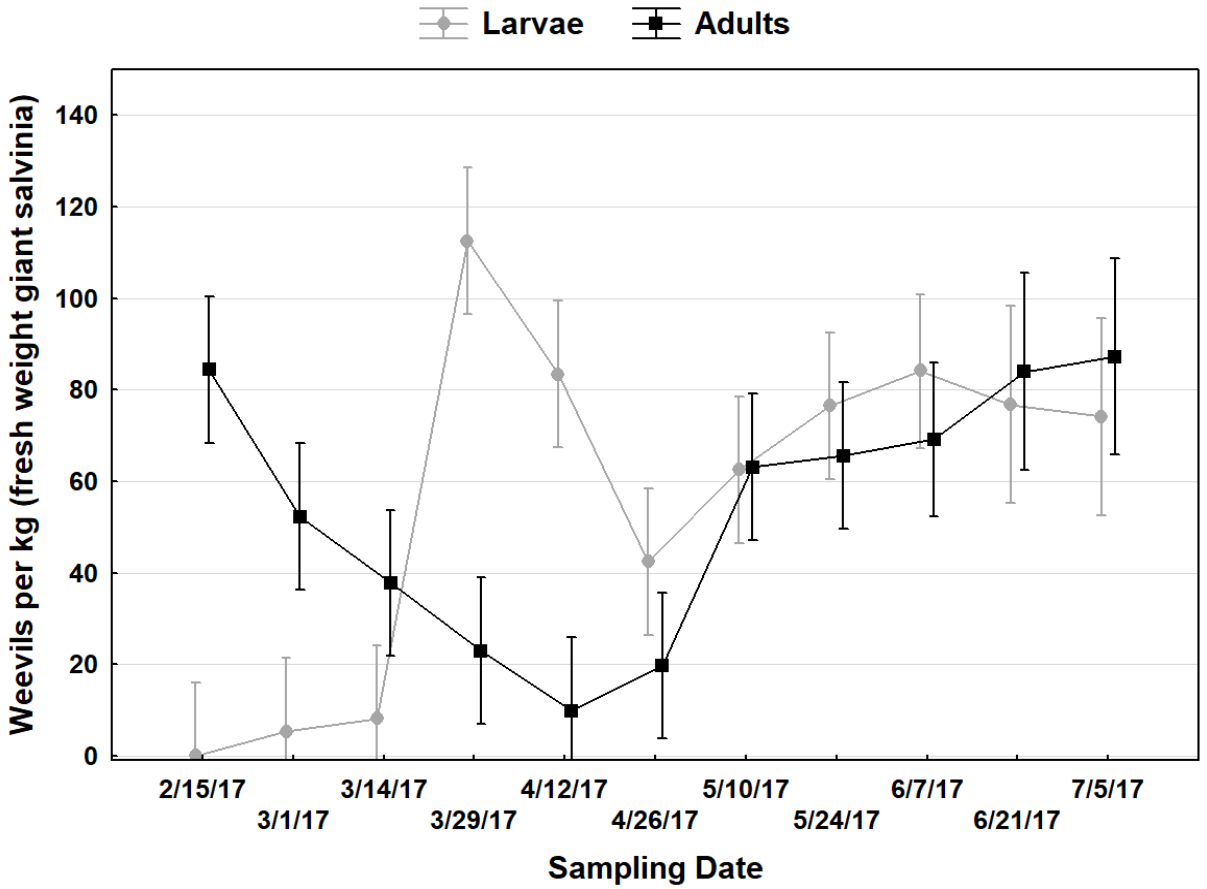
# Established & Self-sustaining Wee

- Lake-wide monitoring 2017
  - Goal
    - To observe and document a naturally occurring, established, and self-sustaining salvinia weevil populatio on a lake-wide scale
  - Sampling
    - 20 stations
    - Every 2 weeks 15 Feb – 5 July
      - Adult and larval weevil density
      - Temperature – continuous, hourly readings
      - Plant nitrogen content
  - Drawdown 15 May – 15 Dec 2017
    - 7 June – 2 stations inaccessible
    - 21 June – 8 stations inaccessible
    - 5 July - 9 stations inaccessible



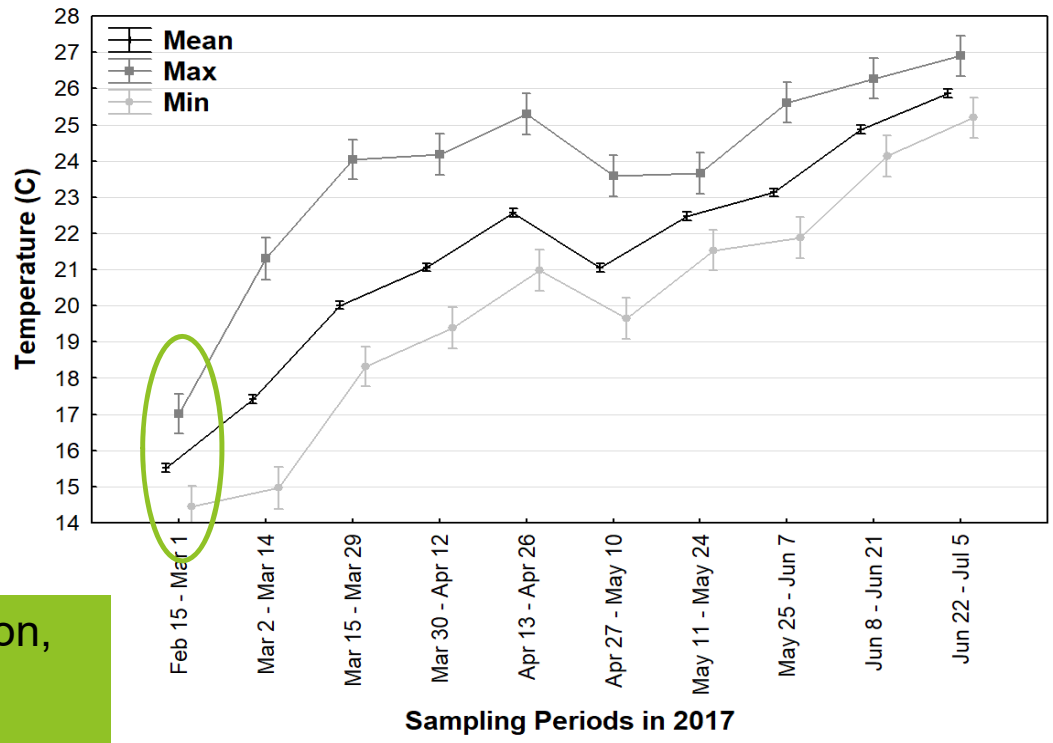
# Established & Self-sustaining Weevils, Central Louisiana

- Population dynamics
  - Early season
    - Adult and larval inverse relationship
      - Overwintered adults mated and died
    - Larval peak in late March
  - Mid season
    - Subequal adult and larval densities



# Established & Self-sustaining Weevils, Central Louisiana

- Salvinia weevil low temperature limits
  - Negligible oviposition
    - 19 – 21°C (66 - 70°F) (Forno et al. 1983)
  - No egg hatch
    - < 19°C (66°F) (Forno et al. 1983)
  - No larval survival
    - < 17°C (63°F) (Sands et al. 1983)
- What about acclimated weevils in natural, fluctuating cold temp regimes?

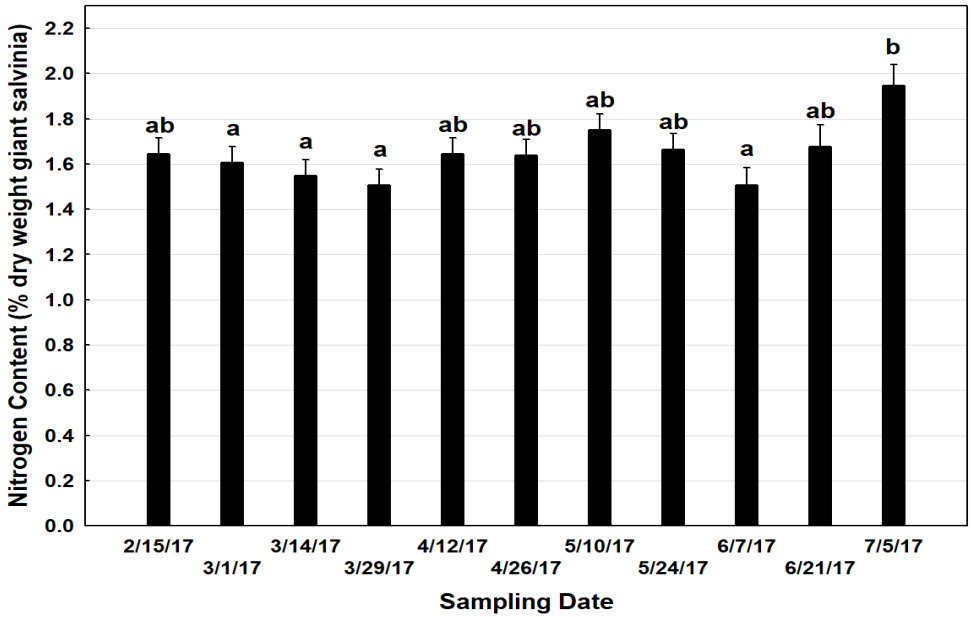



Mating, oviposition, and egg hatch

14.5 - 17° C

# Established & Self-sustaining Weevils, Central Louisiana

- Increased giant salvinia nitrogen content
  - < larval development time (Sands et al. 1983)
  - > egg production (Sands et al. 1986)
  - > weevil growth rate (Sands et al. 1983)
  - > 3% dry weight nitrogen optimum (Room et al. 1989)
  - < 1.5% dry weight nitrogen
    (Nachtrieb 2019 & Nachtrieb et al. 2019)
    - ▸ Reduced weevil density
    - ▸ Limited establishment
- Lake Iatt
  - 1.50 – 1.94% dry weight nitrogen
  - Sufficient to support sustained salvinia weevil establishment and growth



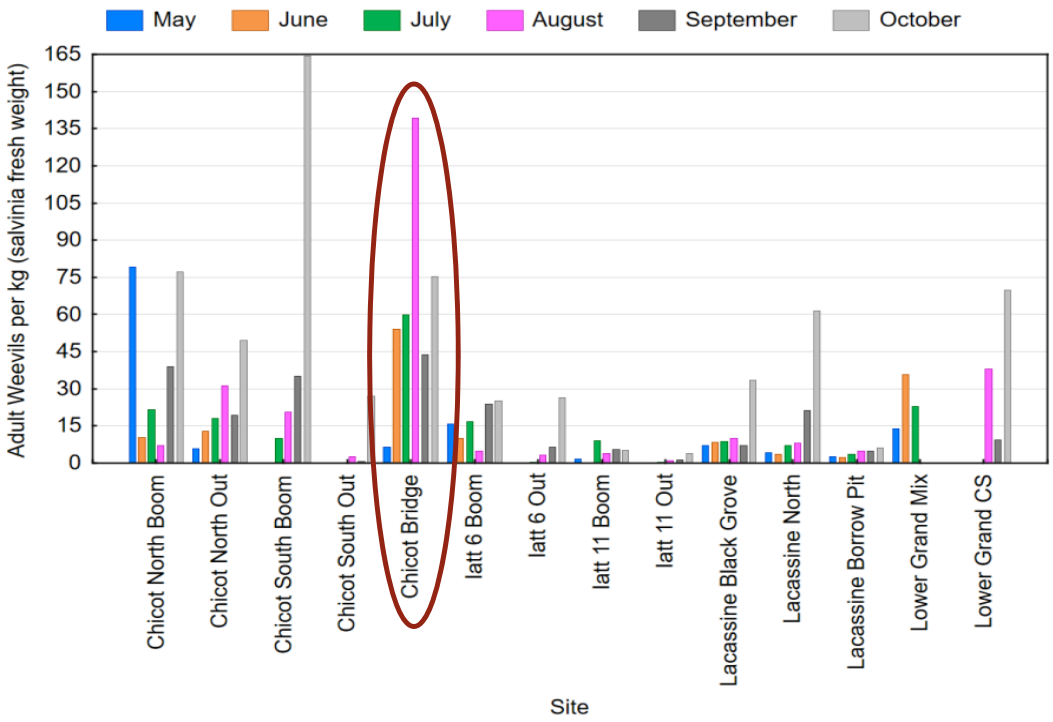
# Consistent Overwintering, Central Louisiana

- Chicot Lake
  - Central Louisiana, 30.82°N 92.27°W
- Bridge Site
  - Year 1, 2017
    - Sept & Oct
      - 93,000 weevils released
    - Successful overwintering
  - Year 2, 2018
    - Apr – Aug
      - 94,000 weevils released
    - Successful overwintering
  - Year 3, 2019
    - No weevil releases
    - Successful management of giant salvinia

**How many salvinia weevils** do you need and **how long does it take** to manage giant salvinia?

# Consistent Overwintering, Central Louisiana

- Chicot, Bridge Site – Year 3
  - Early season weevil population explosion
  - **Adult weevil density**
    - **May to June**
      - **8 fold increase**
        - » **6.6 to 54 adults per kg**
    - **July**
      - **Stable**
        - » **60 adults per kg**
    - **August**
      - **Peaked at 139 adults per kg**
        - » **Greater than all other sites by at least 4 fold**
  - Larval weevil density
    - August
      - Peaked at 102 larvae per kg



# Consistent Overwintering, Central Louisiana

- Chicot, Bridge Site – Year 3
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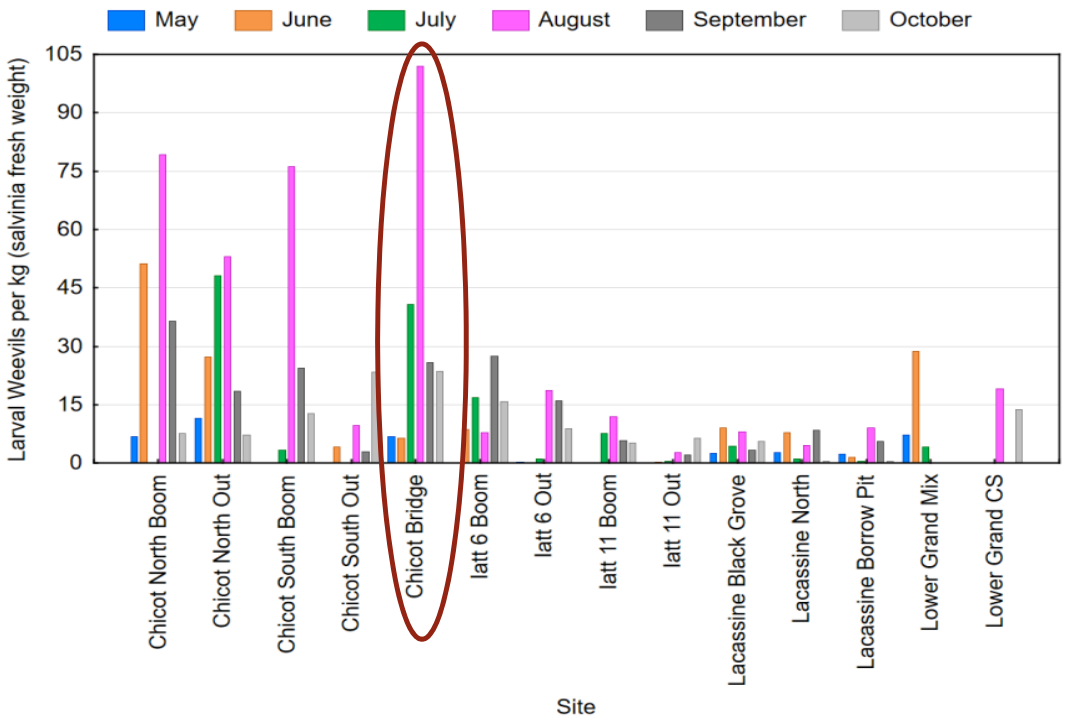
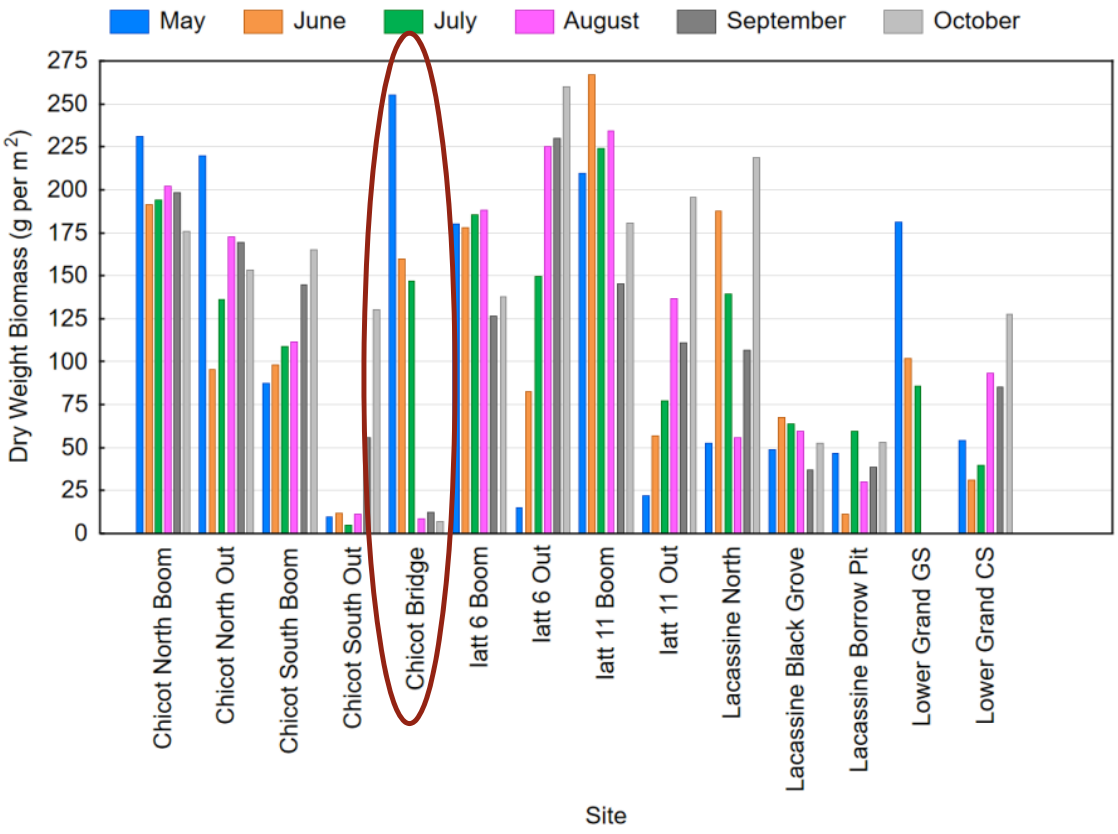


# Consistent Overwintering, Central Louisiana

- Chicot, Bridge Site – Year 3
  - **Dry weight biomass**
    - **May**
      - **Greatest biomass of all sites**
    - **July to August**
      - **94% reduction**
    - **August to October**
      - **Lowest biomass of all sites**
  - Percent Cover
    - July to August
      - 88% reduction
    - August to October
      - Range of 8 - 10%



# Consistent Overwintering, Central Louisiana

- Chicot, Bridge Site – Year 3
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    - May
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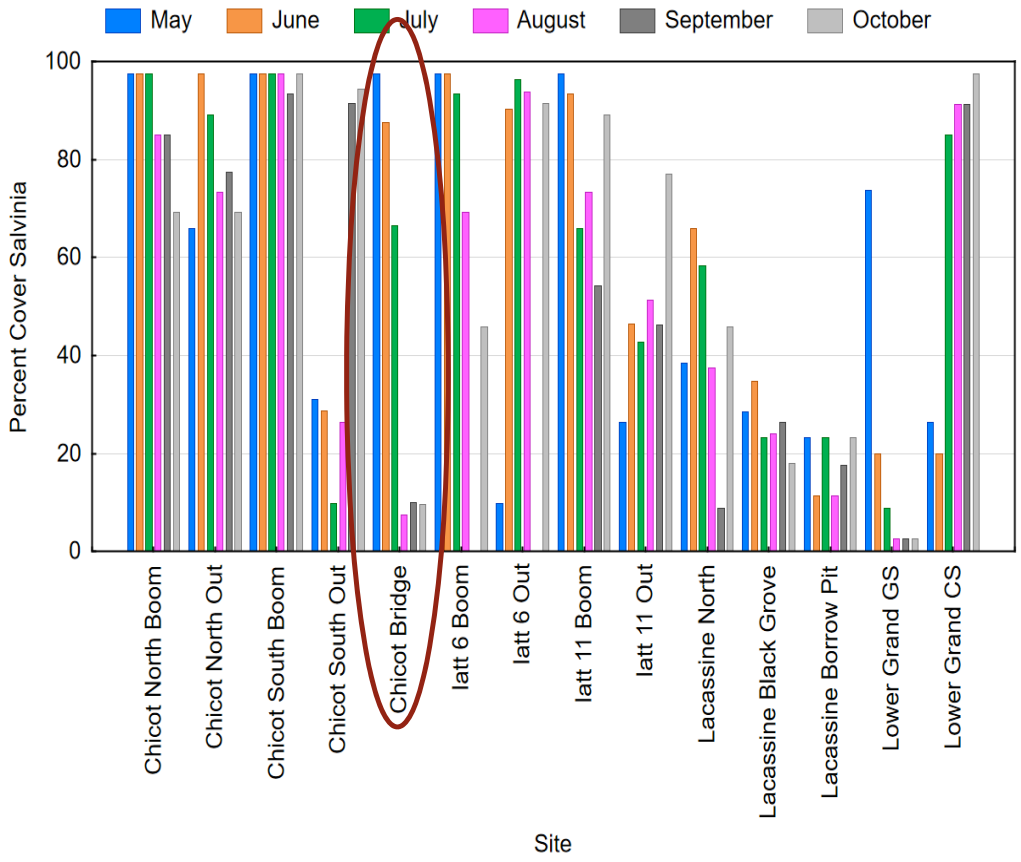
  - **Percent Cover**
    - **July to August**
      - **88% reduction**
    - **August to October**
      - **Range of 8 - 10%**



# Consistent Overwintering, Central Louisiana

**How many salvinia weevils** do you need and **how long does it take** to manage giant salvinia?

**The recipe for success at Chicot, Bridge Site**

**Two years of successful overwintering**
**+**
**Early season spike in adult density**
**+**
**Two months of sustained 50-60 adults per kg**
**=**
**Successful management of giant salvinia**

**Weevil overwintering is the 1st key to management success.**

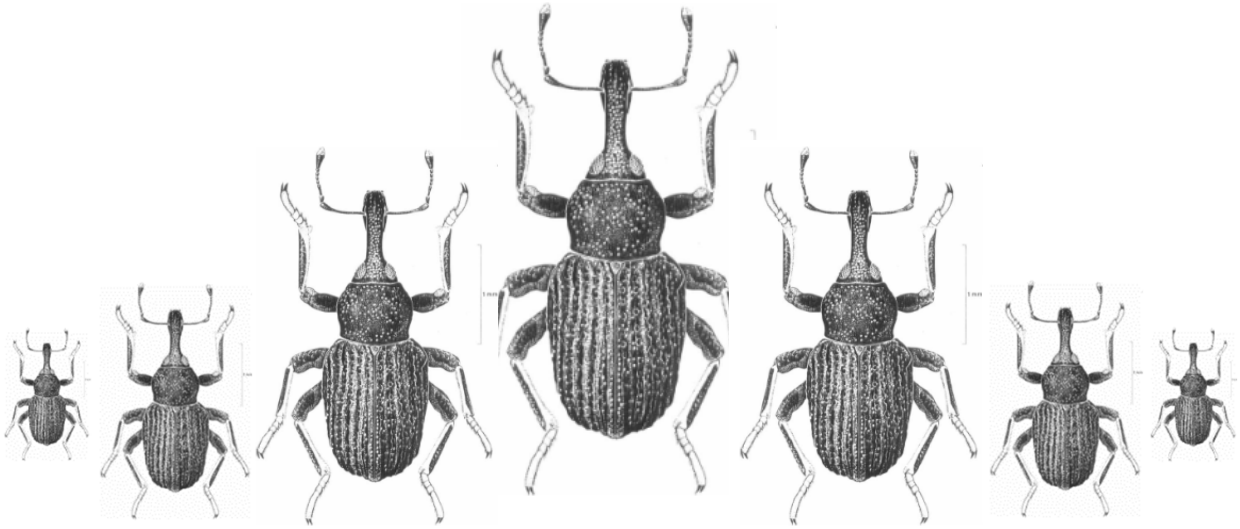
# The Take-Home Message

**Successful overwintering is needed for sustained salvinia weevil establishment and management of giant salvinia.**

- Integrated management
  - Salvinia weevils respond well to lake-wide water level draw downs & herbicide treatments

# Funding Provided By

## Louisiana Department of Wildlife and Fisheries
## &
## US Army Corps of Engineers Aquatic Plant Control Research Program

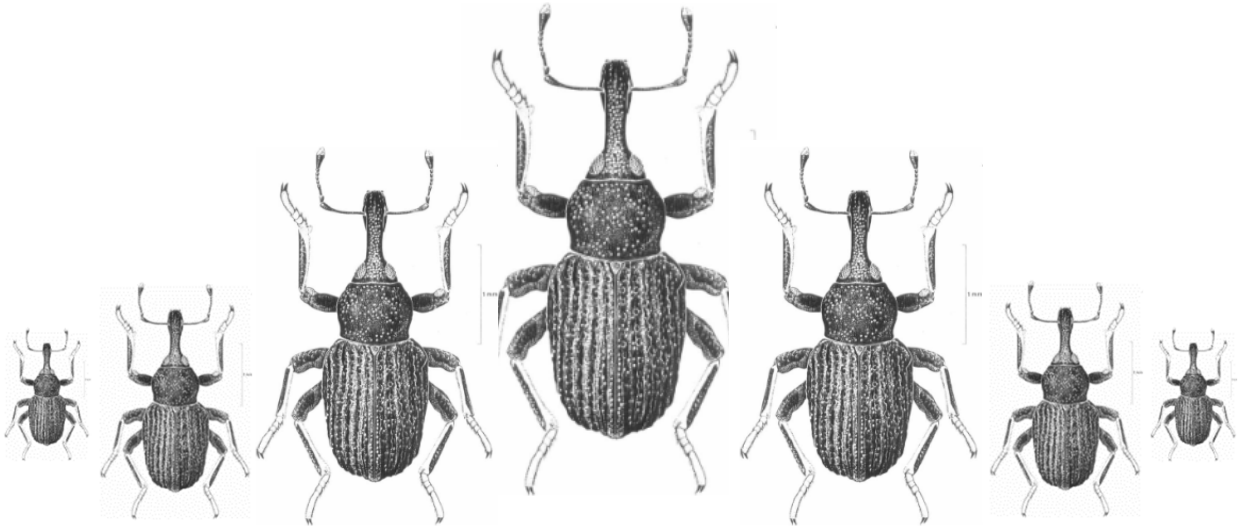


# Acknowledgements

**LDWF: Kane Finkbeiner & Wesley Maddox**

**&**

**USACE: Katie Vasquez & Ricardo Luna**



# Updates on biological control of giant salvinia from LSU

Rodrigo Diaz, Christopher Mudge, Nathan Harms, and Salvinia TEAM

LSU Department of Entomology

LSU AgCenter Research · Extension · Teaching

Louisiana Department of Wildlife & Fisheries

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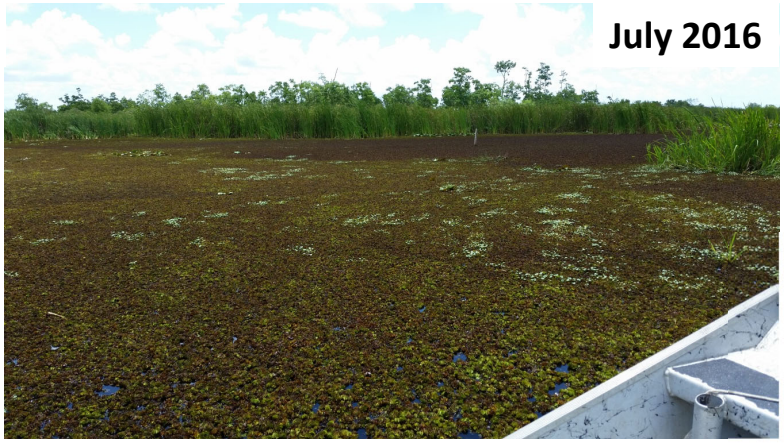
# We need to fight against the superfast growth of Salvinia

**USDA 2012.** Federal Noxious Weed List

## Since de 90s, the salvinia weevil (*Cyrtobagous salviniae*) has been used for biological control around the world


- Native from Brazil
- Highly successful in South LA and Texas

# Mild winter and widespread dispersal leads to rapid control in south LA

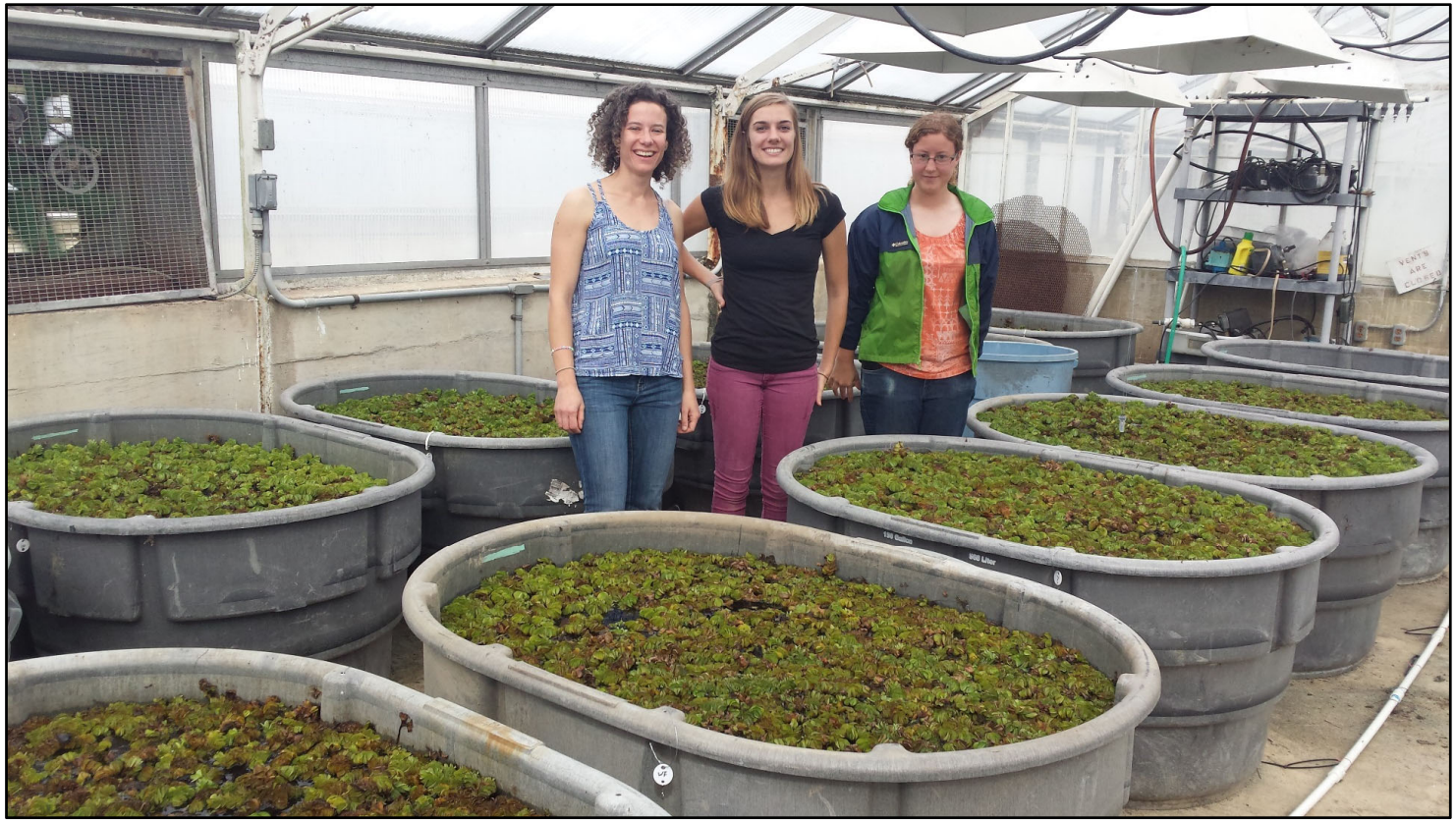



# Mass rearing of salvinia weevils by LSU

# Ponds located in central-south LA to avoid cold winters

Large amounts of biomass (weevils) can be produced in a small area

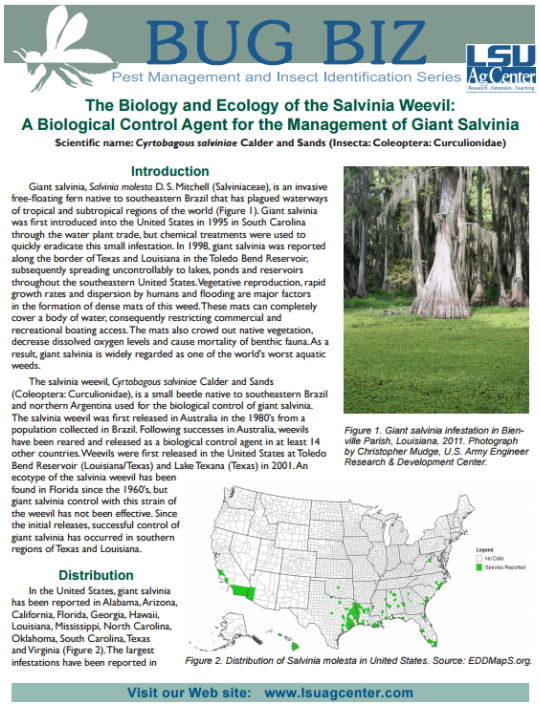
**In the winter, we move a small colony into the greenhouse…just in case**



# We provide weevils to managers of public waterbodies and private land owners

**In addition to LA, weevils shipped to South Carolina, Mississippi, Florida, Texas, Puerto Rico, Cameroon, South Africa**

# LSU participates actively on the development of educational materials about salvinia



BUG BIZ

Pest Management and Insect Identification Series

LSU AgCenter

**The Biology and Ecology of the Salvinia Weevil: A Biological Control Agent for the Management of Giant Salvinia**

**Scientific name: *Cyrtobagous salviniae* Calder and Sands (Insecta: Coleoptera: Curculionidae)**

## Introduction

Giant salvinia, *Salvinia molesta* D. S. Mitchell (Salviniaceae), is an invasive free-floating fern native to southeastern Brazil that has plagued waterways of tropical and subtropical regions of the world (Figure 1). Giant salvinia was first introduced into the United States in 1995 in South Carolina through the water plant trade, but chemical treatments were used to quickly eradicate this small infestation. In 1998, giant salvinia was reported along the border of Texas and Louisiana in the Toledo Bend Reservoir, subsequently spreading uncontrollably to lakes, ponds and reservoirs throughout the southeastern United States. Vegetative reproduction, rapid growth rates and dispersion by humans and flooding are major factors in the formation of dense mats of this weed. These mats can completely cover a body of water, consequently restricting commercial and recreational boating access. The mats also crowd out native vegetation, decrease dissolved oxygen levels and cause mortality of benthic fauna. As a result, giant salvinia is widely regarded as one of the world's worst aquatic weeds.

The salvinia weevil, *Cyrtobagous salviniae* Calder and Sands (Coleoptera: Curculionidae), is a small beetle native to southeastern Brazil and northern Argentina used for the biological control of giant salvinia. The salvinia weevil was first released in Australia in the 1980's from a population collected in Brazil. Following successes in Australia, weevils have been reared and released as a biological control agent in at least 14 other countries. Weevils were first released in the United States at Toledo Bend Reservoir (Louisiana/Texas) and Lake Texana (Texas) in 2001. An ecotype of the salvinia weevil has been found in Florida since the 1960's, but giant salvinia control with this strain of the weevil has not been effective. Since the initial releases, successful control of giant salvinia has occurred in southern regions of Texas and Louisiana.

*Figure 1. Giant salvinia infestation in Bienville Parish, Louisiana, 2011. Photograph by Christopher Mudge, U.S. Army Engineer Research & Development Center.*

## Distribution

In the United States, giant salvinia has been reported in Alabama, Arizona, California, Florida, Georgia, Hawaii, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Texas and Virginia (Figure 2). The largest infestations have been reported in

*Figure 2. Distribution of Salvinia molesta in United States. Source: EDDMapS.org.*

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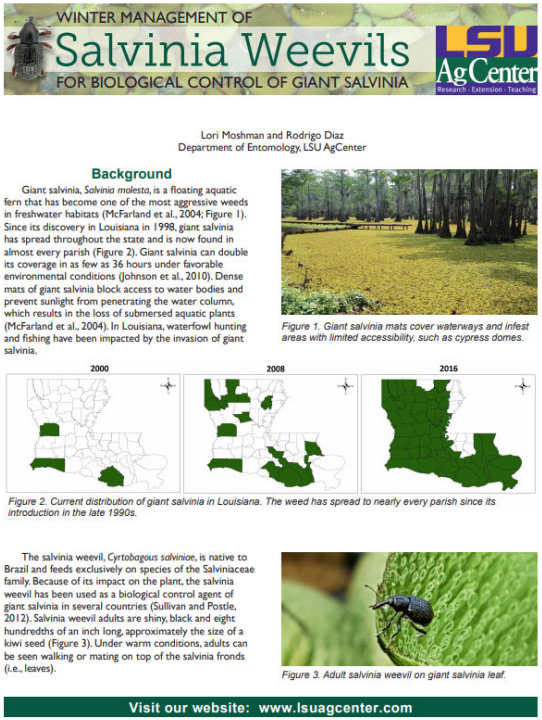

WINTER MANAGEMENT OF

Salvinia Weevils

FOR BIOLOGICAL CONTROL OF GIANT SALVINIA

LSU AgCenter

Research · Extension · Teaching

Lori Moshman and Rodrigo Diaz
Department of Entomology, LSU AgCenter

## Background

Giant salvinia, *Salvinia molesta*, is a floating aquatic fern that has become one of the most aggressive weeds in freshwater habitats (McFarland et al., 2004; Figure 1). Since its discovery in Louisiana in 1998, giant salvinia has spread throughout the state and is now found in almost every parish (Figure 2). Giant salvinia can double its coverage in as few as 36 hours under favorable environmental conditions (Johnson et al., 2010). Dense mats of giant salvinia block access to water bodies and prevent sunlight from penetrating the water column, which results in the loss of submersed aquatic plants (McFarland et al., 2004). In Louisiana, waterfowl hunting and fishing have been impacted by the invasion of giant salvinia.

*Figure 1. Giant salvinia mats cover waterways and infest areas with limited accessibility, such as cypress domes.*

2000 2008 2016

*Figure 2. Current distribution of giant salvinia in Louisiana. The weed has spread to nearly every parish since its introduction in the late 1990s.*

The salvinia weevil, *Cyrtobagous salviniae*, is native to Brazil and feeds exclusively on species of the Salviniaceae family. Because of its impact on the plant, the salvinia weevil has been used as a biological control agent of giant salvinia in several countries (Sullivan and Postle, 2012). Salvinia weevil adults are shiny, black and eight hundredths of an inch long, approximately the size of a kiwi seed (Figure 3). Under warm conditions, adults can be seen walking or mating on top of the salvinia fronds (i.e., leaves).

*Figure 3. Adult salvinia weevil on giant salvinia leaf.*

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1

How to Release and Monitor

SALVINIA WEEVILS

for Biological Control of Giant Salvinia in Louisiana

LSU AgCenter

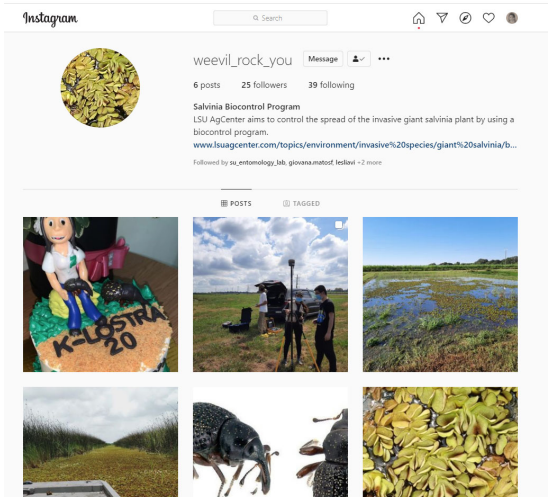
Research · Extension · Teaching

Lori Moshman, Charles Wahl, and Rodrigo Diaz
Department of Entomology
LSU AgCenter

**www.lsuagcenter.com/giantsalvinia**

# We use different platforms to disseminate educational content

- Short videos are the best!
- LSU AgCenter Communications helps us on social media
- Facebook
- Instagram



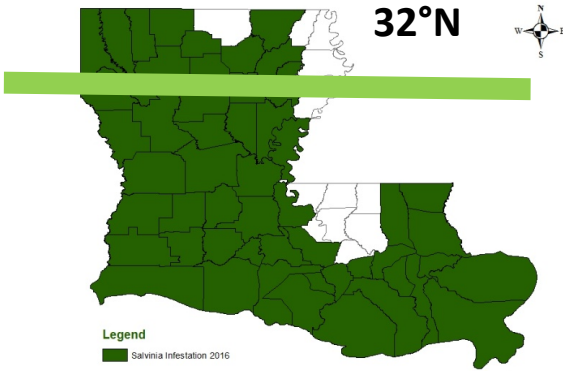


**https://www.instagram.com/weevil_rock_you/**

# Research projects on salvinia at LSU


Why so much interest on biological control? By far this is the most cost effective method of control.

# Cold tolerance: Winters in north Louisiana, Arkansas and Mississippi affect the survival of the weevil

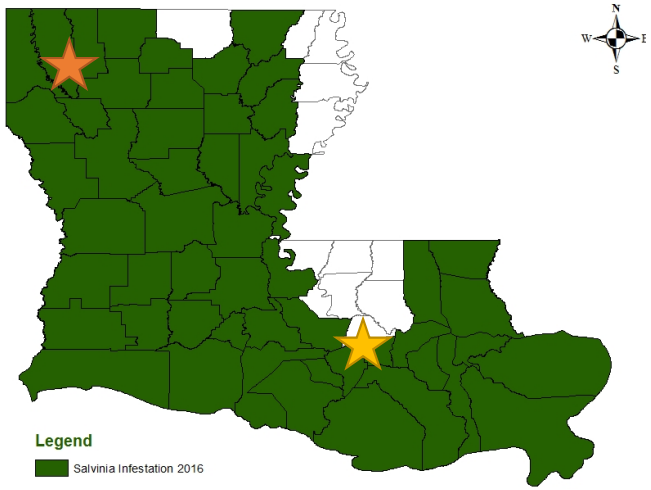



**Mukherjee et al. 2014.** BioControl 59: 781-790

**J. Sibley**

# Research on winter dynamics in north and south LA

- Cross Lake and Saint Gabriel

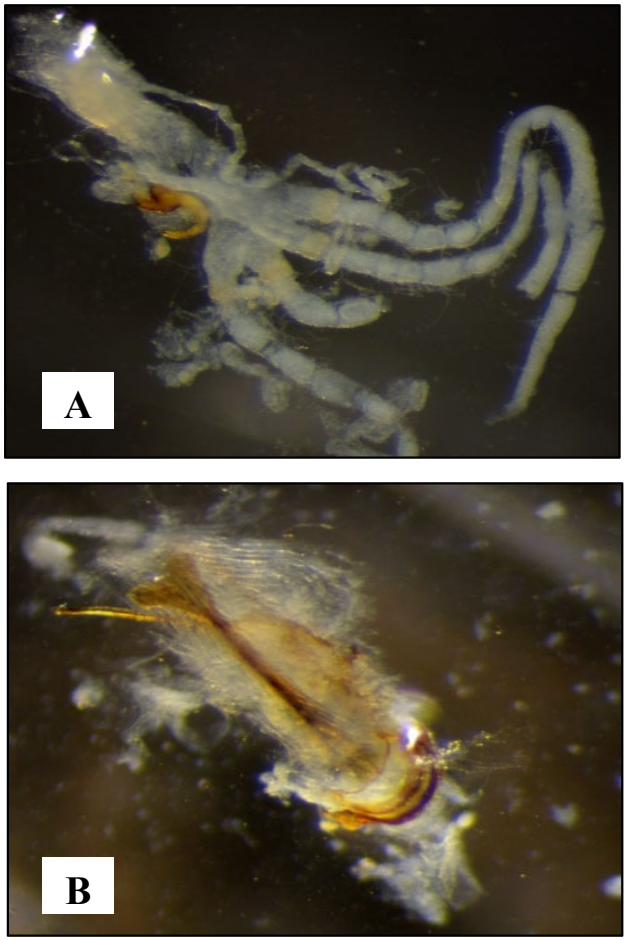



Comparative work will help to find bottlenecks in the system

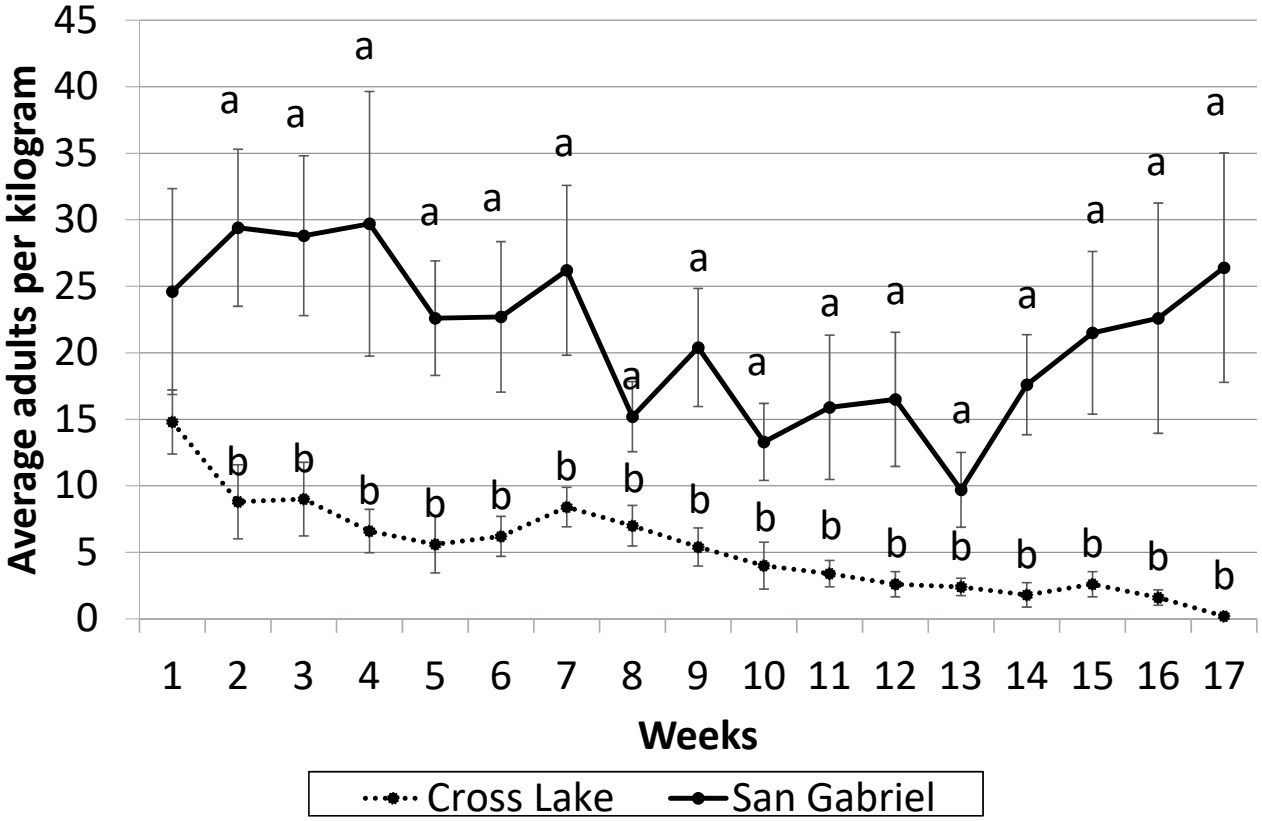
# Weekly samples collected from January to May 2020

## We dissected females to determine the reproductive condition

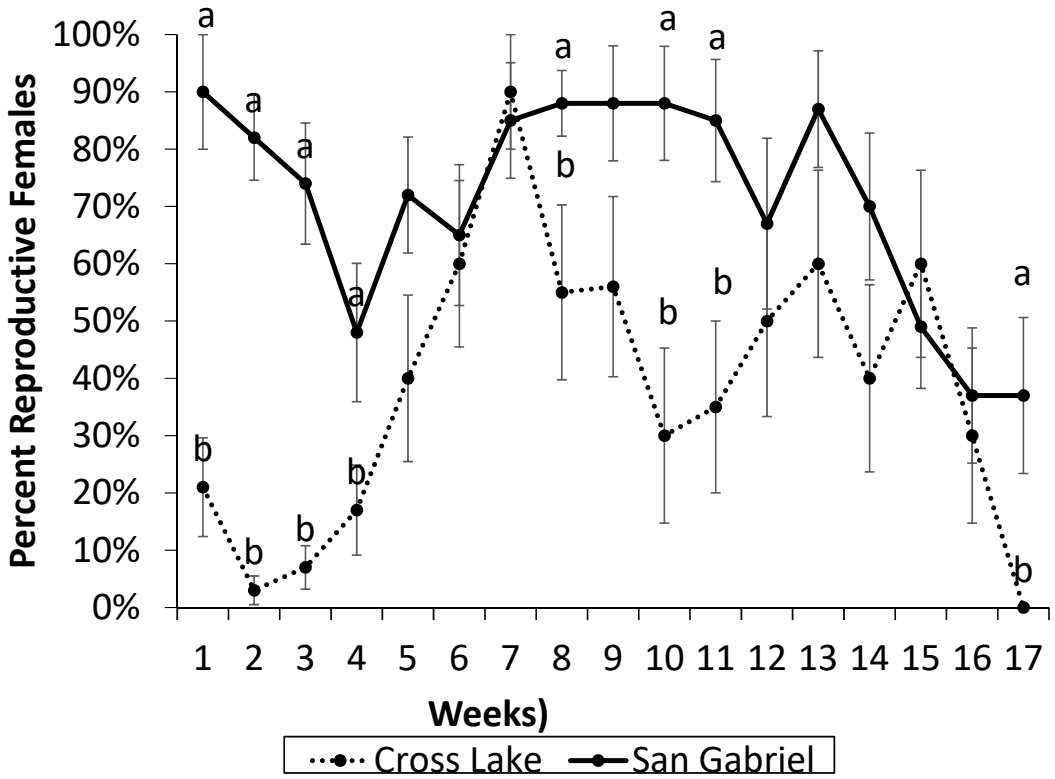
- Presence or abscence of immature eggs



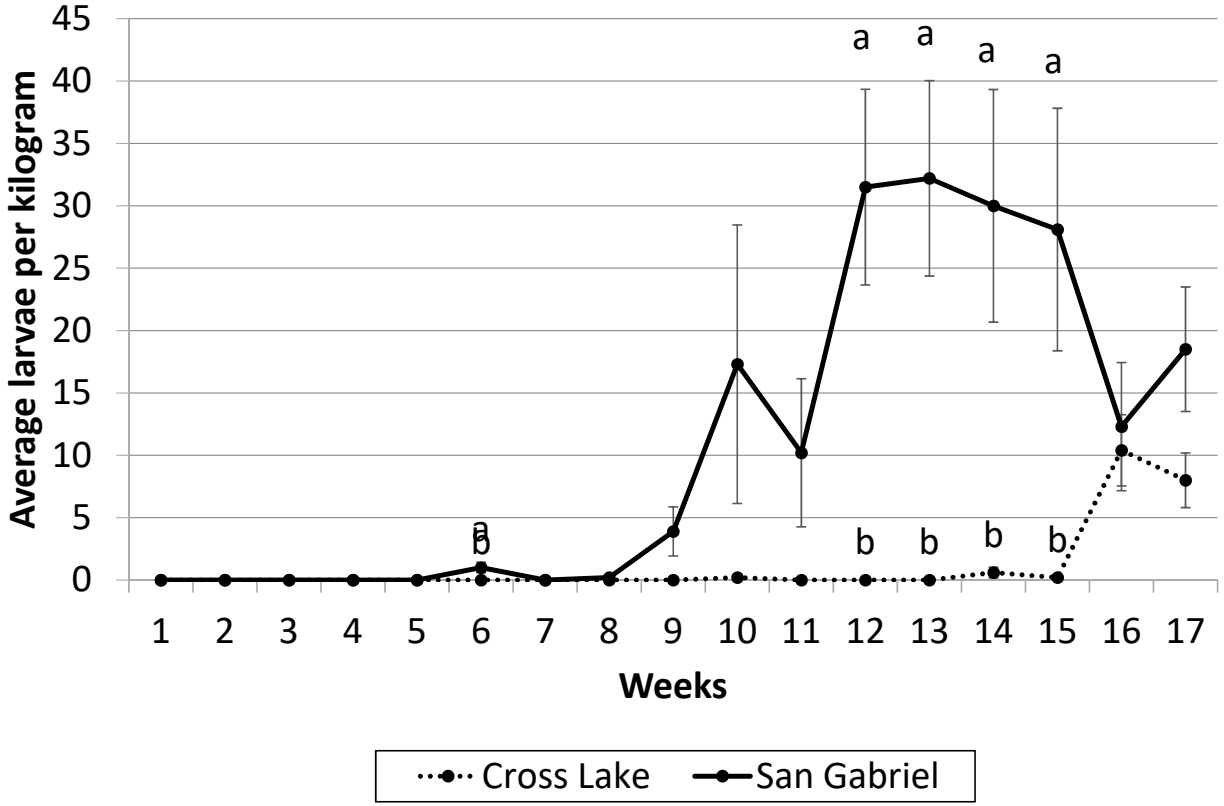
# We found higher density of adults in St. Gabriel and the population recover faster in spring



# Equal proportion of reproductive females during February and May



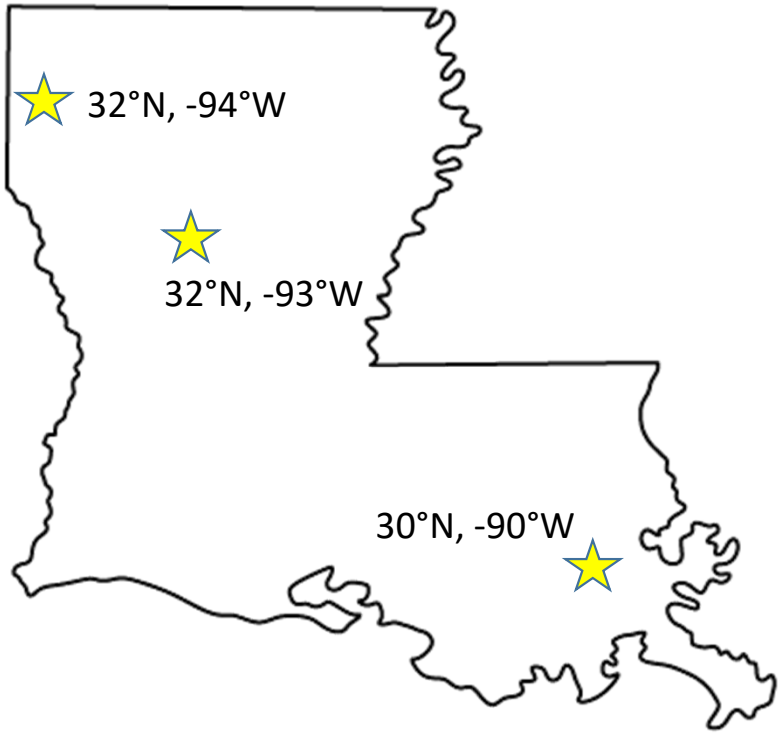
# Larvae showed up later in St. Gabriel, thus delaying population growth



## We evaluated the use of fabrics to raise winter temperatures

## We evaluated increasing density of salvinia to raise temperatures

# Field evaluation of salvinia densities to raise winter temperatures




| Treatments | |
|---|---|
| Low | 3.5 kg/m$^2$ |
| Medium | 7.0 kg/m$^2$ |
| High | 10.5 kg/m$^2$ |

# Cooperation with USACE and LDWF: Development of a cold tolerant weevil

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URUGUAY

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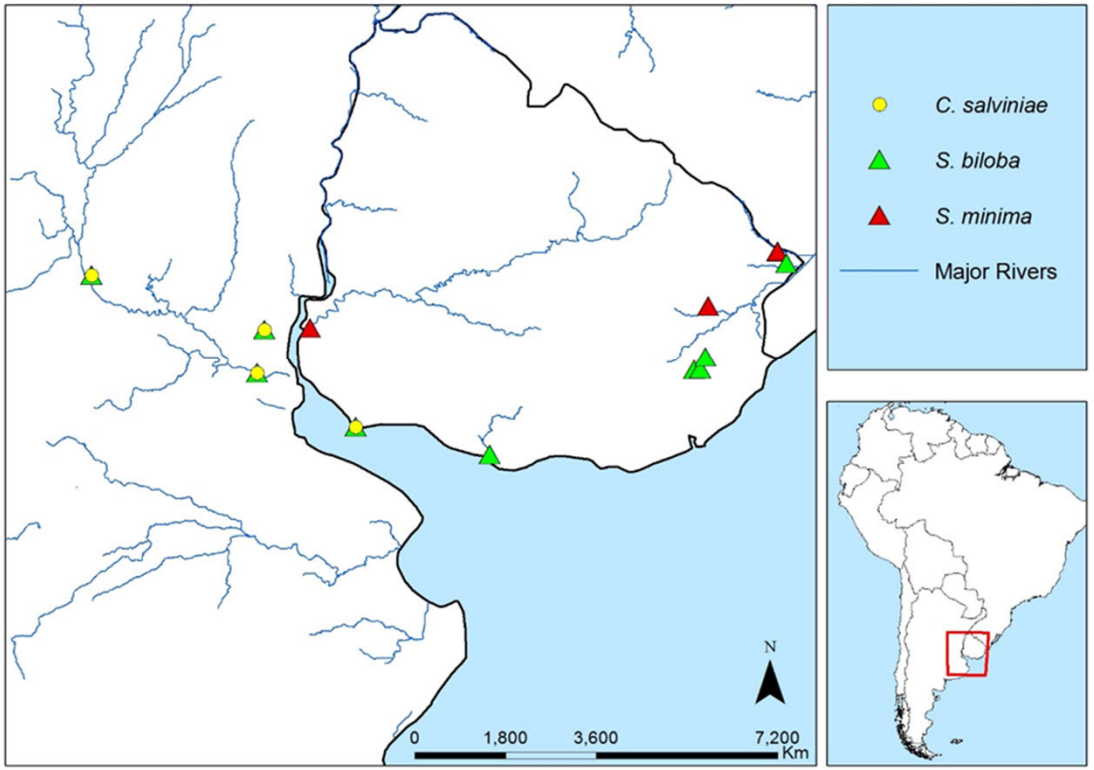
# *Cyrtobagous salviniae* collected from Argentina y Uruguay

- Paraná Delta
- **33 a 34° S latitude**
- *S. biloba* and *S. herzogii*



# Critical: Confirm identification of the weevil and compare cold tolerance with LA population

Contents lists available at ScienceDirect

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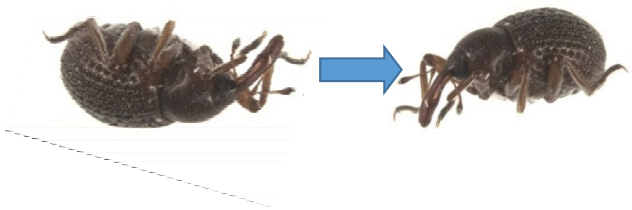
journal homepage: www.elsevier.com/locate/ybcon

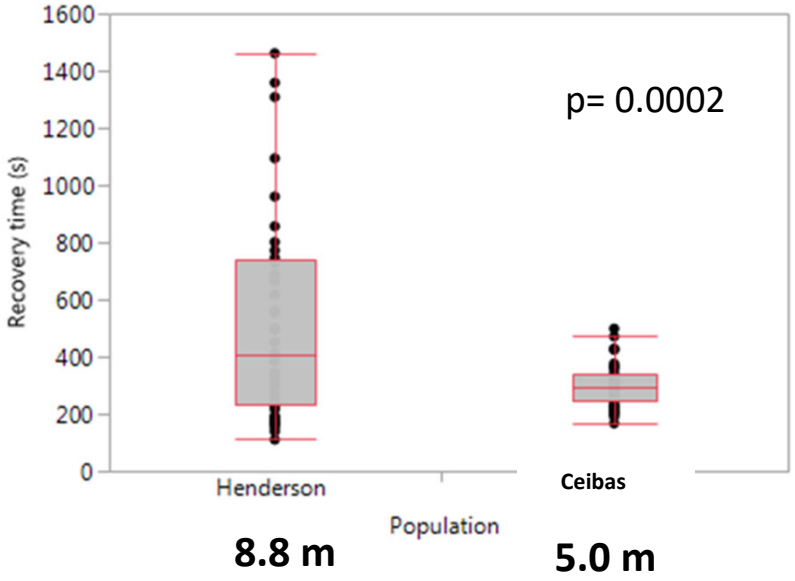
## Surveys in Argentina and Uruguay reveal *Cyrtobagous salviniae* (Coleoptera: Curculionidae) populations adapted to survive temperate climates in southeastern USA

Alana Russell [a], Seth Johnson [a], Ximena Cibils [b], Fernando McKay [c], Lori Moshman [a], Paul Madeira [d], Zizah Blair [d], Rodrigo Diaz [a,*]

[a] Department of Entomology, Louisiana State University, Baton Rouge, USA
[b] Instituto Nacional de Investigación Agropecuaria, INIA LA Estanzuela, Uruguay
[c] Fundación para el Estudio de Especies Invasivas, Buenos Aires, Argentina
[d] Invasive Plant Research Laboratory, United States Department of Agriculture, ARS, Fort Lauderdale, USA

# Weevils from Argentina recovered faster after exposure to 0°C



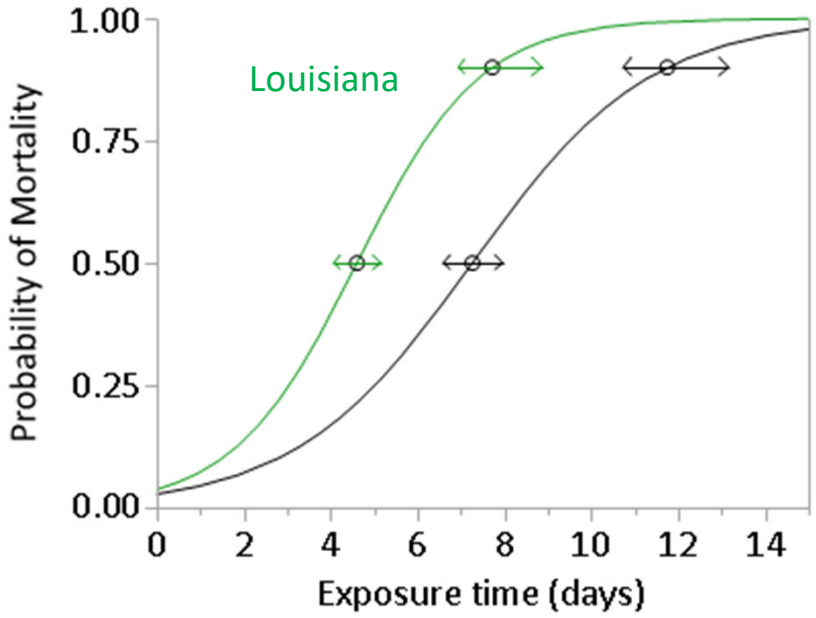



**8.8 m** **5.0 m**

**1.8-times faster**

# Adult mortality after exposure to 0°C

Survival to 0°C was **1.5**-times greater for Argentina compared to Louisiana




Current work: raise the Argentinean population in quarantine and apply to USDA-APHIS permit of release.

# Final message

## Biological control is the most sustainable method of control of salvinia

1. We need to fight early in the season, by summer is more expensive.

2. Mass rearing of weevils is key for areas with low weevil densities

3. Research: Efforts focused on improving survival during cold winter in northern regions

Thank you!

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