Monitoring invasive FAV, focusing on *Salvinia* bio-control effectiveness

Julie Whitbeck, Jean Lafitte NHP&P
*(drawing on the effort of 10 steward-interns and many volunteers)*
overview

• Why monitor FAV, *Salvinia* and a bio-control weevil?
• landscape and hydrologic context
• history
• motivation (reprise)
• what we did: developing the protocol
• how we did it & who did it
• what we did: using & improving the protocol
• what we learned
• What’s next?
Why monitor FAV, Salvinia and a bio-control weevil?
Salvinia impacts

- Forms Dense Mats
  - Fishing and boat access
  - Light availability to subsurface
  - Surface area for gas exchange
  - Substrate for other invasive spp
- S. molesta grows extremely quickly
  - Competes with native FAV
  - Food availability and quality
Cyrtobagous salviniae

Commonly known as the “Salvinia weevil”

Native to South America

Feeds solely on the buds and leaves of Salvinia

Two major Ecotypes
- smaller (Florida) ecotype prefers S. minima
- larger (Brazil) ecotype prefers S. molesta

Both released in LA
JELA Monitoring Program

Goals:
- Evaluate populations of Salvinia and Weevils
- Understand Weevil-Salvinia relationship:
  Are the weevils doing their job? How can we measure success?
- Inform future management
  Where do we need more weevils? When should we introduce them?
context
Jean Lafitte National Historical Park and Preserve
1. Sale - Cypremont
   4600 years BP
2. Teche
   3500 - 2800 years BP
3. St. Bernard
   2800 - 1000 years BP
4. Lafourche
   1000 - 300 years BP
5. Plaquemine
   750 - 500 years BP
6. Balize
   550 years BP
You are here . . . at the Barataria Preserve in the Mississippi River delta engaging the challenges of managing this human modified deltaic wetland landscape
South Louisiana: Why so many invasives?

Major port -- species come from around the world

Ecosystems highly disturbed, fragmented

Mild winters; freezes becoming rarer

Result: 25% of plant spp. in Louisiana are non-native
history
Salvinia

Two species: *S. minima* (common) & *S. molesta* (giant)

Native to SE Brazil, found in U.S. in 1995 (aquarium trade)

Common Salvinia:
arrived in JELA ~ 1988

Giant Salvinia:
arrived ~2006
The Salvinia Biocontrol Project

- Preserve began regular introduction of weevils in 2011
- Initial goals were to:
  - Effectively introduce weevils
  - Observe if weevil population would survive and grow in our system
  - Observe if weevils controlled Giant Salvinia
Biocontrol: 2011-2014 weevil release sites at JELA’s Barataria Preserve
motivation
Park mission & management guidance

• Canoe trails program – recreation & enjoyment

• Control and reduce/eliminate invasive species

• Many invasive species included in the Floating Aquatic Vegetation (FAV) community

• Portfolio of management approaches
Strategies for Controlling Salvinia

Mechanical  Chemical  Biological
Management Methods

How to Manage Invasives?

• Mechanical Control
  – Hand pulling
  – Draining water basin

• Chemical Control
  – Herbicide Sprays

• Biological Control
  – Introduce natural predator or native competitors

Challenges & Benefits

• Expensive, requires repetition, (for FAV) removes entire community, but usually non-toxic

• Can kill other species (e.g. native plants), toxins may persist, requires repetition, but often effective

• Typically species-specific, potential ecological damage to habitat, but long-term effective control
what we did: developing the protocol
Methods

Samples of *Salvinia molesta* were collected from infested and non-infested waterways, and Berlese funnels were used to determine weevils per gram of salvinia. The population density of each waterway was compared to theoretical stable population densities found at *C. salviniae* breeding ponds from the LSU AgCenter. Additional weevil-populated Giant Salvinia was gathered from the breeding ponds and distributed throughout Lower Kenta Canal, which had population densities below stable levels. Emergent aquatic vegetation surveys were conducted for future comparison purposes.

**Fig. 1.** Berlese funnels were made out of a 3-liter bottle, wire mesh, and a clamp light. The salvinia was placed on the wire mesh, and the weevils were collected in the petri dish.

**Fig. 2.** Dumping weevil-populated salvinia from the ponds into Kenta Canal.
SEPTEMBER - OCTOBER 2013:
SALVINIA AND MOSQUITO MONITORING
METHODS

- Sampled weevil populations
- Sampled larval mosquitoes

Compared with
Habitat Measurements:
- Water temperature
- pH
- Specific Conductivity
- Salinity
- Dissolved Oxygen
- Canopy Cover
- Vegetation Cover
The Sampling Sites

- 24 sites
  - 3 each from different waterway and swamp locations
  - Set A sites are waterways, weevils introduced
  - Set B sites are mostly swamp areas, no weevils introduced (by the Preserve)
Original Methods

- Salvinia sampled from 1m² PVC quadrat
- Water quality measurements
- Sample dried in Burlese funnel for 48 hours
- Count weevils for population density estimate
- Use image analysis to estimate % cover of Salvinia
who did the work
Salvinia and larval mosquito monitoring in the Jean Lafitte National Park and Preserve
Volunteer Coordination

- Volunteers in Resource Management
- The calendar
- Outreach
- How to Continue
Volunteers in Resource Management

- Several long-term projects that require regular sampling.
- More time, energy, labor = volunteers!
- **Importance of understanding to stewardship**
  - BUT
  - Most of our projects require experience/training
  - General lack of understanding of what RM is/does.
JELA-BTNEP Environmental Stewards
using & improving the protocol
Floating Aquatic Vegetation Monitoring Program Sampling Protocol

for Volunteers and Resource Management Staff at
Jean Lafitte National Historical Park & Preserve

(revised March 2016)

Julie Whitbeck – JELA Ecologist
Gina Botello Young – Environmental Steward - 2013
Christa Russell – Environmental Steward - 2014
Joy Semien – Volunteer - 2014
Erik Iverson – Environmental Steward - 2015
Megan Exniclos – Environmental Steward - 2015
2 sets of sampling sites:

- 12 Canal sites - sampled every 2 weeks
- 9 Swamp, 3 Canal sites - every 4 weeks

Also:

- 12 Open Water sites, accessed via airboat
  - sampled once
Swamps
Canals (Waterways)

Upper TC
Lower Twin Canals
Middle Kenta
Bayou Coquille
Palmetto Trail
Bayou Des Families
Visitor’s Center
Ring Levee
JELA Monitoring Program

Using a 1m² quadrat, we record:

- Water quality
- Temperature
- pH
- Specific Conductivity
- Salinity
- Dissolved Oxygen

- Canopy Cover

- Water depth
JELA Monitoring Program

Using a 1m² quadrat, we record:
  Abundance of 9 key plant species

Also collect quart sized sample of Salvinia when present

Take photos for image analysis
JELA Monitoring Program

Samples are dried using Berlese funnels

- Record wet and dry mass
- Collect and count weevils

# Weevils / g dry mass is our measure of weevil abundance
Using a grid, we calculate:

- *Salvinia* percent cover
- Other plant percent cover
- Water percent cover
- Score Browning (0-4)

Salvinia/Water ratio is our measure of Salvinia cover
what we learned
# Results of Monitoring

## Different Aquatic Freshwater Habitats

<table>
<thead>
<tr>
<th></th>
<th>Swamp</th>
<th>Canal Bank</th>
<th>Open Water</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Depth:</strong></td>
<td>5”</td>
<td>13”</td>
<td>38”</td>
</tr>
<tr>
<td><strong>Canopy:</strong></td>
<td>72%</td>
<td>52%</td>
<td>5%</td>
</tr>
</tbody>
</table>
Abiotic Factors over time
## Influences on Salvinia - Habitat

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<tbody>
<tr>
<td><em>Salvinia</em></td>
<td>84%</td>
<td>70%</td>
<td>40%</td>
</tr>
<tr>
<td><em>Hyacinth</em></td>
<td>4%</td>
<td>18%</td>
<td>24%</td>
</tr>
</tbody>
</table>

Winter Avg Cover: 18%
Summer Avg Cover: 70%
Abiotic Influences on Salvinia

Salvinia grows in spring, peaks late summer, crashes in winter

Factor Analysis of Mixed Data:

- A technique for simplifying a multivariate dataset
- Handles categorical & quantitative data
- Reduces variation to two dimensions

![Correlation circle diagram](image-url)
Abiotic Influences on Salvinia

Canopy Cover: + corr
Water Temp: + corr

Dissolved Oxygen: - corr

Specific Conductivity: no corr

Growth: 10° - 40°C  Optimum: 30°C
# Influences on Weevils - Habitat

<table>
<thead>
<tr>
<th>Weevils / g</th>
<th>Swamp</th>
<th>Canal Bank</th>
<th>Open Water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.83</td>
<td>2.44</td>
<td>0.53*</td>
</tr>
</tbody>
</table>
Abiotic Influences on Weevils

Weevils grow through late summer and fall, peak and persist through winter, and crash in spring.

- Canopy Cover: - corr
- Dissolved Oxygen: - corr
- Temperature: + corr
- Specific Conductivity: + corr

Growth: 21°C - 31°C  
Optimum: 25.5°C
Weevil/Salvini Relationship - Seasonality

Canal Bank:

Salvinia Cover (%)

Weevil Dry Density (Weevils/g)
Weevil/Salvini Relationship - Seasonality

Swamp:

![Graph showing the relationship between Salvinia Cover (%) and Weevil Dry Density (Weevils/g) from March 2014 to October 2015.](image)
Weevil/Salvinia Relationship - Browning

No correlation between Salvinia Cover, Weevils
Hard to account for lag time

What about browning?
When Salvinia is dying, it turns brown

Browner sites have more weevils
Browning - Seasonality

The graph shows the extent of browning from March 2014 to October 2015 for canal banks and swamps. The blue line represents canal banks, and the red line represents swamps. The x-axis represents the months from March 2014 to October 2015, while the y-axis represents the extent of browning from 0 to 3.5.
Weevil/Salvinia Relationship

Browning, not Salvinia cover, predicts weevil density

But canopy cover & seasonality are confounding sources of browning

No statistical correlation between weevil density, Salvinia cover

Including one month lagging, leading for each
Parys & Johnson 2013--Weevils reduced Salvinia biomass, but not cover

But weevils appear to track Salvinia cover in a possible predator-prey relationship

Relationship might be detected with more data, better models
Conclusions--Managing Salvinia

Weevils appear to have been effective at controlling Giant Salvinia

Abiotic factors have greater influence on Common Salvinia than weevils do

Salvinia recovers from winter faster than weevils do
recommendations
Recommendations

Drop large numbers of weevils in the spring
   Bolster weevils at their lowest
   Cut-off Salvinia before it blooms

Hot-spot areas of Giant Salvinia

Focus on canals, but don’t neglect swamps

Drop mainly Florida (smaller) ecotype
   Use populations from N. Florida--cold tolerance
Recommendations

Continue monitoring

Use experimental introductions to assess weevil efficacy
   Different ecotypes, different control method combos

Determine what actually causes weevils to crash
   Not Salvinia, not temperature alone....
How You Can Control the Spread

- **Step One:** Be familiar with the plant
- **Step Two:** Check your shoes, boats, trailer, etc. every time you leave infested waters.
- **Step Three:** Spread the knowledge!
What’s next?
Acknowledgements & thanks

JELA staff

All volunteers

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BTNEP
great thanks

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• Clare Lister
• Nuri Melancon

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• Charlsie Shaver
• Arye Janoff
• David
• Sarah Soleiman
• Paris Evans
• Madison Berard
• Joy Semien
• Laura Rack
• Chris and Bill
• Molly Fava
• Erika Weideman
• Elliot Weidow
• 2016 TU Wetlands Ecology class
Influences on Salvinia - Seasonality

Canal Bank:
Influences on Salvinia - Seasonality

Swamp:

The graph shows the percentage of Salvinia cover over time from March 2014 to October 2015. The y-axis represents the percent Salvinia cover, while the x-axis represents the date. The data points indicate a peak in Salvinia cover during late summer and early fall, followed by a decline in fall and winter, and an increase again in early spring.
Influences on Weevils - Seasonality

Canal Bank:
Influences on Weevils - Seasonality

Swamp:

![Graph showing average weevil density (weevils/g) over time from March 2014 to October 2015]
# Weevils & Salvinia - Relationship

## Weevils & Salvinia--July 2015

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<tbody>
<tr>
<td><strong>Weevil Dens:</strong></td>
<td>.83/g</td>
<td>2.43/g</td>
<td>.53/g*</td>
</tr>
<tr>
<td><strong>Salvinia:</strong></td>
<td>84%</td>
<td>70%</td>
<td>40%</td>
</tr>
<tr>
<td><strong>Browning:</strong></td>
<td>21%</td>
<td>23%</td>
<td>67%</td>
</tr>
</tbody>
</table>