FWC Research

- Developing Novel Use Patterns for Newly Registered Herbicides on Water Hyacinth and Water Lettuce (FY13-14)

- Development of Use Patterns for Combining Glyphosate and Protox Inhibiting Herbicides for Control of Invasive Emergent and Floating Aquatic Plants (FY14-15)
Floating Invasive Species

- Water hyacinth and water lettuce
  - Problematic for 100+ years

- 2,4-D and diquat have been mainstays of control for 50+ years
  - Cost effective control methods
  - Can lack selectivity especially for key native species
Problem

- 2,4-D and diquat use - strong visual injury symptoms or control of non-target natives
- Treating mixed communities of invasive and non-target species results in short term injury or death
  - Bulrush, spikerush, sagittaria, pickerelweed, etc.
- Stakeholder emphasis on improving selectivity and reducing visual injury
Mixed Target/Non-target Communities
New Herbicide Use Patterns

- Low dose tank mix partners of ALS + contact herbicides provide visual markers and increase speed of control
  - Systemic: Imazamox, Penoxsulam, or Bispyribac
  - Contact: Carfentrazone, Flumioxazin, or Diquat

- Increased use of penoxsulam, flumioxazin, imazamox, carfentrazone, and bispyribac for selective plant management
Materials and Methods

- Greenhouse and mesocosm research
- 2013 to 2015
- Vicksburg, Baton Rouge, and Gainesville
- Trials conducted 4 to 8 WAT
Bispyribac Combinations vs. Water Hyacinth & Non-targets

- Bispyribac (1 and 2 oz/A)
- Bispyribac (1 oz) + Carfentrazone (1 oz/A)
- Bispyribac (1 oz) + Diquat (1 oz/A)
- Bispyribac (1 oz) + Endothall (1 oz/A)
- Bispyribac (1 oz) + Flumioxazin (0.5 oz/A)
- Non-targets: giant bulrush, soft-stem bulrush, maidencane, club-rush, and spikerush
Bispyribac Alone & Combos vs. W. Hyacinth

Mean Dry Weight (g/tank)

Herbicide Treatments

- Control
- B
- B + C
- B + D
- B + E
- B + F

a, bc, b, bc, c
Bispyribac Alone & Combos vs. Non-targets

- Bispyribac alone = no visual injury, stunting/growth inhibition
- Bispyribac + contacts = necrosis/chlorosis 1 to 14 DAT (or none)
- No biomass reductions to giant bulrush, maidencane, and club-rush
Bispyribac Alone & Combos vs. Water Hyacinth & Non-targets
Carfentrazone & Flumioxazin vs. W. Hyacinth, W. Lettuce & Spatterdock

- PPO herbicides applied at low concentrations (50 ppb) to selectively control water lettuce
- Subsurface activity on w. hyacinth and spatterdock?
- Subsurface (ppb)
  - Carfentrazone 25, 50, 100, 150, and 200
  - Flumioxazin 50 and 100
- Foliar (g a.i. ha\(^{-1}\))
  - Carfentrazone 33.3, 66.6, and 99.9 (2, 4, and 6 oz/A)
Innovative solutions for a safer, better world

Carfentrazone & Flumioxazin vs. W. Hyacinth

Carfentrazone: 52 to 62% hyacinth control

Flumioxazin: 43% hyacinth control

Concentrations ≥50 ppb provided 100% lettuce control

Complete recovery with 25 ppb carfentrazone

C = Carfentrazone
F = Flumioxazin
Carfentrazone & Flumioxazin vs. Immature Spatterdock

All treatments resulted in 51 to 99% control

Minimal recovery by 100 ppb carfentrazone treated plants and no recovery from 200 ppb

All plants treated with foliar carfentrazone, 50 ppb carfentrazone and subsurface flumioxazin recovering 4 WAT

Limit subsurface carfentrazone use to 50 ppb in hyacinth/lettuce mixed populations with spatterdock
Carfentrazone and Flumioxazin vs. Spatterdock and Water Hyacinth

Control (4 WAT)               Carfentrazone 4 oz/A (4 WAT)               Flumioxazin 50 ppb (4 WAT)

Control (6 WAT)               Carfentrazone 25 ppb (6 WAT)               Flumioxazin 50 ppb (4 WAT)
FWC Research

- Developing Novel Use Patterns for Newly Registered Herbicides on Water Hyacinth and Water Lettuce (FY13-14)

- Development of Use Patterns for Combining Glyphosate and Protox Inhibiting Herbicides for Control of Invasive Emergent and Floating Aquatic Plants (FY14-15)
Difficult to Control Invasive Species

- Complete emergent/floating plant control required due to monoculture or no selectivity
- Multiple herbicide applications, tank mixes, and disregard for selectivity to control
- Examples: crested floating heart, ludwigia spp. torpedograss, giant salvinia, common salvinia, and alligatorweed
Glyphosate + PPO Herbicides

- Glyphosate + Flumioxazin or Carfentrazone
  - Highly efficacious and limited selectivity
  - Synergistic or additive effect?
  - Rates and use patterns unknown

- Limited literature on combination treatments in Agriculture or Aquatic Weed Sci.

- Combination effective against crested floating heart and giant salvinia
Glyphosate + PPOs vs. Torpedograss

Control (5 WAT)  Glyphosate 32 oz/A (5 WAT)  Glyphosate 96 oz/A (5 WAT)

Glyphosate 96 oz/A + Flumioxazin 4 oz/A (5 WAT)  Glyphosate 96 oz/A + Carfentrazone 4 oz/A (5 WAT)
### Glyphosate + PPOs vs. Torpedograss

**5 WAT**

<table>
<thead>
<tr>
<th></th>
<th>G32</th>
<th>G32</th>
<th>G32</th>
<th>G96</th>
<th>G96</th>
<th>G96</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>G32</td>
<td>G32</td>
<td>G32</td>
<td>G96</td>
<td>G96</td>
<td>G96</td>
</tr>
<tr>
<td></td>
<td>+ F4</td>
<td>+ C4</td>
<td>+ F4</td>
<td>+ C4</td>
<td>+ F4</td>
<td>+ C4</td>
</tr>
</tbody>
</table>
Glyphosate + Flumioxazin vs. Crested Floating Heart (6 WAT)
Future Research

- Continued evaluation of glyphosate + flumioxazin/carfentrazone vs. emergent weeds
  - Alligatorweed, giant salvinia, water hyacinth, cattail, giant cutgrass, etc.
- Current project ends this FY (‘14-15)
Publications


Thank You!

- Invasive Plant Management Section, Florida Fish and Wildlife Conservation Commission Bureau

- 2013-2014 research was leveraged with the Aquatic Plant Control Research Program
  - Phytotoxicity of New Aquatic Herbicides on Non-Target Plants Work Unit