2015 Statistical Surveys for Wastewater Tracers and Imidacloprid

Division of Environmental Assessment and Restoration
May 17, 2017
Overview

✓ Background Information
✓ % Sites with Detections
✓ Magnitude of Detections
✓ Estimate of Extent of Resource with Detections
✓ Correlations with Land Use
✓ Summary
2015 Sample Surveys

- Sucralose, pharmaceuticals and Imidacloprid collected at 528 sites
  - 60 canal sites
  - 90 river sites
  - 90 stream sites
  - 90 large lake sites
  - 78 small lake sites
  - 120 unconfined wells
Sample Surveys for Sucralose

% Status Sites with Detectable Sucralose

- Canals
- Rivers
- Streams
- Large Lakes
- Small Lakes
- Unconfined Aquifers
- Confined Aquifers

2012 | 2014 | 2015
2015 Sample Surveys

% Status Sites with Detectable Pharmaceuticals

- **Acetaminophen**
  - 9 detections (2 ng/L to 11 ng/L) only one quantified.

- **Carbamazapine**
  - 82 detections of carbamazepine (0.44 ng/L to 68 ng/L) 21 quantified. Notice the MDL is ~ an order of magnitude lower than Acetaminophen/Primidone

- **Primidone**
  - 11 detections (5.8 ng/L to 88 ng/L) two quantified.
2015 Sample Surveys

% Status Sites with Imidacloprid Detections

- 210 detections (2.1 ng/L to 520 ng/L), 103 quantified.
### Compound Half-lives and Aquatic Life Toxicology Values

<table>
<thead>
<tr>
<th>Compound</th>
<th>Half-life Water</th>
<th>Predicted No Effect Concentrations (PNEC)</th>
<th>LC$_{50}$ Insect</th>
<th>LC$_{50}$ Crustacean</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sucralose</td>
<td>&gt; year</td>
<td>930 μg/L</td>
<td>NA</td>
<td>NA</td>
<td>Tollefsen et al. 2012$^1$</td>
</tr>
<tr>
<td>Acetaminophen</td>
<td>weeks</td>
<td>9.2 μg/L</td>
<td>NA</td>
<td>NA</td>
<td>Kim et al. 2007, Table 3$^2$</td>
</tr>
<tr>
<td>Carbamazepine</td>
<td>weeks</td>
<td>31.6 μg/L</td>
<td>NA</td>
<td>NA</td>
<td>Kim et al. 2007, Table 3$^2$</td>
</tr>
<tr>
<td>Primidone</td>
<td>weeks</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Imidacloprid</td>
<td>weeks</td>
<td>1/10$^{th}$ LC$_{50}$</td>
<td>0.65 - 44 μg/L</td>
<td>7.1 - 361 μg/L</td>
<td>Goulson 2013, Table S1$^3$</td>
</tr>
</tbody>
</table>

### US EPA Pesticide Registration Program Benchmarks$^4$

<table>
<thead>
<tr>
<th>Compound</th>
<th>Half-life Water</th>
<th>Benchmark - Fish (Acute)</th>
<th>Benchmark - Fish (Chronic)</th>
<th>Benchmark - Invert (Acute)</th>
<th>Benchmark - Invert (Chronic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imidacloprid</td>
<td>weeks</td>
<td>&gt;41,500 μg/L</td>
<td>1200 μg/L</td>
<td>35 μg/L</td>
<td>1.05 μg/L</td>
</tr>
</tbody>
</table>

2015 Sample Surveys

Range of Detected Values

Water Resource:
- Unconfined Aquifer
- Small Lake
- Large Lake
- Small Stream
- Large River
- Canal

Concentration (ng/L):
- Sucralose
- Carbamazepine
- Imidacloprid
Range of Detected Values vs Available Aquatic Life Toxicology Guidance

1. Sucralose, Acetaminophen, Carbamazepine – highest values are an order of magnitude lower than any known toxicology guidance

2. Imidacloprid – 47/210 sites’ detections are higher than Goulson’s suggested 1/10\textsuperscript{th} of the \text{LC}_50 lower range.
### Percentage of Water Resource Expected to Have Detectable Amounts of Wastewater Tracers

<table>
<thead>
<tr>
<th>Water Resource</th>
<th>Target Population Size*</th>
<th>Number of Samples</th>
<th>% of Resource Expected to Have Sucralose Only with Upper/Lower 95% Confidence Bounds</th>
<th>% of Resource Expected to Have Sucralose and at least one Pharma with Upper/Lower 95% Confidence Bounds</th>
<th>% of Resource Expected to Have No Sucralose and at Least One Pharma Detection with Upper/Lower 95% Confidence Bounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canals</td>
<td>4066</td>
<td>60</td>
<td>46.2&lt;br&gt;33.6 - 56.8&lt;br&gt;10.8&lt;br&gt;3.6-17.8&lt;br&gt;NA**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Streams</td>
<td>26175.1</td>
<td>89</td>
<td>35.2&lt;br&gt;23.3-47.1&lt;br&gt;23.5&lt;br&gt;13.9-33.1&lt;br&gt;3.4&lt;br&gt;1.2-27.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rivers</td>
<td>4308.3</td>
<td>90</td>
<td>43.2&lt;br&gt;33.0-53.5&lt;br&gt;30.9&lt;br&gt;21.5-40.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large Lakes</td>
<td>408378.3</td>
<td>90</td>
<td>80.5&lt;br&gt;73.0-88.0&lt;br&gt;8.4&lt;br&gt;2.5-14.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Lakes</td>
<td>9521.5</td>
<td>78</td>
<td>30.8&lt;br&gt;17.0-44.5&lt;br&gt;11.6&lt;br&gt;2.0-21.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unconfined Aquifers</td>
<td>15559</td>
<td>118</td>
<td>23.5&lt;br&gt;9.9-37.0&lt;br&gt;6.9&lt;br&gt;0-14.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Units are as follows: canals, streams, and rivers = kilometers; lakes = hectares, unconfined aquifers = number of wells.
## Percentage of Statewide Water Resource Having Detectable Amounts of Imidacloprid

<table>
<thead>
<tr>
<th>Water Resource</th>
<th>Target Population*</th>
<th>Number of Samples</th>
<th>% of Resource Expected to Have Imidacloprid</th>
<th>95% Confidence Bounds</th>
<th>Assessment Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canals</td>
<td>4066</td>
<td>60</td>
<td>50.3</td>
<td>38.2-62.4</td>
<td>Jan.-Feb 2015</td>
</tr>
<tr>
<td>Streams</td>
<td>26175.1</td>
<td>89</td>
<td>36.9</td>
<td>27.9-45.9</td>
<td>July-Aug. 2015</td>
</tr>
<tr>
<td>Rivers</td>
<td>4308.3</td>
<td>90</td>
<td>64.8</td>
<td>54.7-74.8</td>
<td>May-June 2015</td>
</tr>
<tr>
<td>Large Lakes</td>
<td>408378.3</td>
<td>90</td>
<td>33.6</td>
<td>14.4-52.8</td>
<td>April-May 2015</td>
</tr>
<tr>
<td>Small Lakes</td>
<td>9521.5</td>
<td>78</td>
<td>50.0</td>
<td>37.5-62.4</td>
<td>Sept.-Oct. 2015</td>
</tr>
<tr>
<td>Unconfined Aquifers</td>
<td>15559</td>
<td>118</td>
<td>24.7</td>
<td>11.1-38.4</td>
<td>Nov.-Dec. 2015</td>
</tr>
</tbody>
</table>

Units are as follows: canals, streams, and rivers = kilometers; lakes = hectares, unconfined aquifers = number of wells.
2015 Sample Surveys
Sucralose

<table>
<thead>
<tr>
<th>Water Resource</th>
<th>Total Number Sites</th>
<th>Sites Sucralose Detections</th>
<th>Estimate of Resource with Detectable Sucralose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unconfined Aquifers</td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
</tr>
<tr>
<td>Small Lakes</td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
</tr>
<tr>
<td>Canals</td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
</tr>
<tr>
<td>Streams</td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
</tr>
<tr>
<td>Rivers</td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
</tr>
<tr>
<td>Large Lakes</td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
</tr>
</tbody>
</table>
2015 Sample Surveys
Pharmaceutics

<table>
<thead>
<tr>
<th>Water Resource</th>
<th>Total Number Sites</th>
<th>Sites Pharma Detections</th>
<th>Estimate of Resource with Detectable Pharmas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unconfined Aquifers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large Lakes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Lakes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Streams</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rivers</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Unconfined Aquifers**
- **Large Lakes**
- **Canals**
- **Small Lakes**
- **Streams**
- **Rivers**
2015 Sample Surveys
Imidacloprid

<table>
<thead>
<tr>
<th>Water Resource</th>
<th>Total Number Sites</th>
<th>Sites Imidacloprid Detections</th>
<th>Estimate of Resource with Detectable Imidacloprid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unconfined Aquifers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large Lakes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Streams</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Lakes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rivers</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Detected Wastewater Tracers Status Network Sampling for 2015 (Canals, Streams, and Rivers)

Legend

Detection Occurrence (sucralose or any one of three pharmaceuticals (acetaminophen, carbamazepine, or primidone))

- Sucralose Only (100)
- Sucralose and any one of the pharmaceuticals (60)
- Pharmaceutical detection (no sucralose) (1)

Sampling site with pharmaceutical or sucralose detections

- Canal (35)
- Stream (54)
- River (72)

Sampling site having no pharmaceutical or sucralose detections

- Canal (25)
- Stream (36)
- River (18)

Florida Counties

Created March 30, 2017 by Andy Woebner of the Watershed Monitoring Section, Division of Environmental Assessment and Restoration, DEP.

The map content is a cartographic representation and is not intended for further analysis.
Detected Wastewater Tracers
Status Network Sampling for 2015 (Lakes)

Legend
Detection Occurrence (sucralose or any one of three pharmaceuticals (acetaminophen, carbamazepine, or primidone)

◇ Sucralose Only (83)
○ Sucralose and any one of the pharmaceuticals (20)
Sampling site with pharmaceutical or sucralose detections

▲ Large lake¹ (68)
♦ Small lake² (35)
Sampling site having no pharmaceutical or sucralose detections

▲ Large lake¹ (22)
♦ Small lake² (43)
Florida Counties

¹ Large lakes are equal to or greater than ten hectares in size.
² Small lakes are equal to or greater than four hectares and less than ten hectares in size.

Created March 30, 2017 by Andy Woebker of the Watershed Monitoring Section, Division of Environmental Assessment and Restoration, DEP.

The map content is a cartographic representation and is not intended for further analysis.
Detected Wastewater Tracers
Status Network Sampling for 2015
(Unconfined Aquifers)

Legend
Detection Occurrence (sucralose or any one of three pharmaceuticals (acetaminophen, carbamazepine, or primidone)
- Sucralose Only (19)
- Sucralose and any one of the pharmaceuticals (9)
Sampling site with pharmaceutical or sucralose detections
- Unconfined aquifer well (28)
Sampling site having no pharmaceutical or sucralose detections
- Unconfined aquifer well (92)
- Florida Counties

Created March 30, 2017 by Andy Woebber of the Watershed Monitoring Section, Division of Environmental Assessment and Restoration, DEP.

The map content is a cartographic representation and is not intended for further analysis.
Imidacloprid Detections
For The Status Network 2015
By Water Resource

Legend

Imidacloprid Detected

- Canals (36)
- Streams (47)
- Rivers (63)
- Large lake (> or = 10 hectares in size) (33)
- Small lake (> or = 4 and < 10 hectares in size) (23)
- Unconfined aquifers (6)

Not Detected

- Canals (24)
- Streams (43)
- Rivers (27)
- Large lake (> or = 10 hectares in size) (57)
- Small lake (> or = 4 and < 10 hectares in size) (55)
- Unconfined aquifers (114)

Total Detections = 208 out of 528 samples collected

Created January 25, 2017 by Andy Woebner of the Watershed Monitoring Section, Division of Environmental Assessment and Restoration, DEP.

The map content is a cartographic representation and is not intended for further analysis.
## 2015 Sample Surveys

### Sucralose

<table>
<thead>
<tr>
<th>Reporting Units</th>
<th>Urban Land Use</th>
<th>Total Number Sites</th>
<th>Sucralose Detected</th>
<th>Gray Means Previously Displayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRWMD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NWFWMD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFWMD WEST</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFWMD EAST</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SJRWMD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWFWMD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2015 Sample Surveys
Sucralose

<table>
<thead>
<tr>
<th>Reporting Units</th>
<th>Urban Land Use</th>
<th>Sucralose Median with min, 25th, 75th, &amp; max</th>
<th>Gray Means Previously Displayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRWMD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NWFWMD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFWMD WEST</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFWMD EAST</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SJRWMD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWFWMD</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2015 Sample Surveys
Sucralose

TMDL Basins
- Everglades
- Florida Keys
- Fisheating Creek
- Lake Okeechobee
- Apalachicola - Chipola
- Suwannee
- Nassau - St Marys
- Everglades West Coast
- Upper St Johns
- Choctawhatchee - St Andrew
- Ochlockonee - St Marks
- Pensacola
- Indian River Lagoon
- Charlotte Harbor
- St Lucie - Loxahatchee
- Perdido
- Caloosahatchee
- Upper East Coast
- St Johns
- Kissimmee River
- Withlacoochee
- Middle St Johns
- Sarasota Bay - Peace - Myakka
- Springs Coast
- Tampa Bay
- Tampa Bay Tributaries
- Southeast Coast - Biscombe Bay
- Lake Worth Lagoon - Palm Beach Coast

Urban Land Use

Total Number Sites

Sucralose Detected

Gray Means
Previously Displayed

Percent

Percent

N = 529
2015 Sample Surveys Pharmaceuticals

Reporting Units

- SRWMD
- NWFWMD
- SFWMD WEST
- SFWMD EAST
- SJRWMD
- SWFWMD

Urban Land Use

Total Number Sites

Pharma Detected

Gray Means Previously Displayed

Maps of Florida showing different regions.
<table>
<thead>
<tr>
<th>Reporting Units</th>
<th>Ag + Urban Land Use</th>
<th>Total Number Sites</th>
<th>Imidacloprid Detected</th>
<th>Gray Means Previously Displayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWFWMD</td>
<td><img src="image1" alt="Graph" /></td>
<td><img src="image2" alt="Graph" /></td>
<td><img src="image3" alt="Graph" /></td>
<td><img src="image4" alt="Graphic" /></td>
</tr>
<tr>
<td>SRWMD</td>
<td><img src="image5" alt="Graph" /></td>
<td><img src="image6" alt="Graph" /></td>
<td><img src="image7" alt="Graph" /></td>
<td><img src="image8" alt="Graphic" /></td>
</tr>
<tr>
<td>SJRWMD</td>
<td><img src="image9" alt="Graph" /></td>
<td><img src="image10" alt="Graph" /></td>
<td><img src="image11" alt="Graph" /></td>
<td><img src="image12" alt="Graphic" /></td>
</tr>
<tr>
<td>SFWMD EAST</td>
<td><img src="image13" alt="Graph" /></td>
<td><img src="image14" alt="Graph" /></td>
<td><img src="image15" alt="Graph" /></td>
<td><img src="image16" alt="Graphic" /></td>
</tr>
<tr>
<td>SFWMD WEST</td>
<td><img src="image17" alt="Graph" /></td>
<td><img src="image18" alt="Graph" /></td>
<td><img src="image19" alt="Graph" /></td>
<td><img src="image20" alt="Graphic" /></td>
</tr>
<tr>
<td>SWFWMD</td>
<td><img src="image21" alt="Graph" /></td>
<td><img src="image22" alt="Graph" /></td>
<td><img src="image23" alt="Graph" /></td>
<td><img src="image24" alt="Graphic" /></td>
</tr>
</tbody>
</table>
2015 Sample Surveys
Imidacloprid
Summary

1. A large percentage of Florida’s freshwater resources were found to be affected by very low concentrations of wastewater compounds and neonicotinoid pesticides.

2. Of the four compounds examined, only imidacloprid was found to exceed any recommended toxicology guidance. 47/528 sites (~9 percent) were found to exceed the lower threshold of the PNEC for insects and crustaceans.

3. Numbers and magnitude of sucralose and pharmaceutical detections are directly correlated with Urban land use within reporting units.

4. Numbers and magnitude of imidacloprid detections are directly correlated with agricultural and urban land use within reporting units.

5. Of the 29 TMDL basins those having estuaries produced the highest percentage of detections for all four compounds.
Next Steps

- We are pursuing means to integrate these indicators into some of our monitoring plans (strategic and basin management action plan monitoring).

- Investigating additional sampling means (passive sampling devices) to collect a more extensive list of contaminants, including hormones.
Acknowledgements

• FDEP, Northwest Florida WMD, & St. Johns River WMD
  • Sampling staff
• David Whiting and Timothy Fitzpatrick FDEP Central Lab
  • Development of laboratory methodologies for EC indicators
• Dr. Tony Olsen US EPA & Dr. Chris Sedlacek WMS FDEP
  • Monitoring Design and Data Analysis
• Andy Woeber & Stephanie Sunderman – WMS FDEP
  • Geographic Information Systems and Quality Assurance