Relationships Between Discharge And Water Quality In Florida Springs

Ann B. Shortelle, Ph.D.
Erich Marzolf, Ph.D.
Suwannee River Water Management District
**Threats to Springs Health**

<table>
<thead>
<tr>
<th>Threat</th>
<th>Florida’s Management Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Quality – Nitrate Eutrophication</td>
<td>Total Maximum Daily Load (TMDL) and Basin Management Action Plan (BMAP)</td>
</tr>
<tr>
<td>Water Quantity – Flow, Level and Velocity</td>
<td>Minimum Flows and Levels (MFLs)</td>
</tr>
<tr>
<td>Biological Community (Invasives &amp; Migratory Restrictions)</td>
<td>Site-Specific Management</td>
</tr>
<tr>
<td>Disturbance (Erosion, Prop Scars, Trampling)</td>
<td>Site-Specific Management</td>
</tr>
</tbody>
</table>
Nutrient BMAPS and Water Use Caution Areas
Suwannee River Water Management District

Degree of UFA Confinement and Regional Drawdown

From: USGS Professional Paper 1403-C, Plate 1, 1988
Minimum Flows and Levels

SRWMD MFL Schedule - 2014

Springs
- Adopted
- 2013
- 2014
- 2015
- 2016

Rivers
- Adopted
- 2013
- 2014
- 2015
- 2016

Lakes
- 2014
- 2015
- 2016
Delineated Springsheds

- Small fraction of identified springs have been delineated
- Creates challenges for cost-effective hydrologic or water quality restoration efforts

Continuous WQ Monitoring Soon
- Ginnie
- Blue Hole (Ichetucknee)
- Royal
- Fanning
- Manatee
- Madison Blue
Ichetucknee Springshed Variation
Wet Vs. Dry

Ichetucknee Headspring (wet)
Blue Hole Group (wet)

(dry)

Sources: Esri, DeLorme, NAVTEQ, TomTom, Increment P Corp., GagaMap, Intermap, GeoBase, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community
Karst Topography
Loss of SAV Is an Expression of Poor Springs Health

Ichetucknee Springs 1995

Ichetucknee Springs 2012

Courtesy: John Moran Photography
Source: SRWMD data, all springs listed have at least one nitrate value, however only those with 5 or more samples since 2000 show a bar.
Nitrate – Flow Relationship

Strong positive correlation supports a view that spring flows are a mix of older less enriched water and younger, shallower water. Identifying these shallow locations is important.

Wekiwa Springs Discharge Vs. NOx-T. Relationship Significant (p~ 0)

\[ y = 0.0429x - 1.5205 \]
\[ R^2 = 0.6161 \]
Springfed River System

Santa Fe River at Hildreth

Nitrate Vs. Flow for Santa Fe River @ Hildreth

\[
y = -0.0002x + 0.9299 \\
R^2 = 0.3399
\]
Nitrate – Flow Relationship

No hint of correlation, let alone positive correlation.
Ginnie Cave Map

Suwannee River Water Management District
# Nitrate Results

<table>
<thead>
<tr>
<th>Nitrate Correlation with Flow</th>
<th>Nitrate Trend Over Time</th>
<th>Positive</th>
<th>None</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td></td>
<td>Ruth / Little Sulfur, Convict, Madison Blue, Silver, Weeki Wachee</td>
<td>Suwannee Blue, Santa Fe, Troy, Telford, Columbia, Falmouth, Palm, Sanlando, Miami</td>
<td>Hornsby, Poe, Little River, Rock, Wekiwa</td>
</tr>
<tr>
<td>None</td>
<td>Manatee, Fanning, Gilchrist Blue, Ginnie, Hart, Rock Bluff, Chassahowitzka, Homosassa, Pump House &amp; Trotter, Silver, Gum Springs, Rainbow</td>
<td>Otter, Rum Island, Wacissa, Alaphaha Rise (weak), Apopka, Starbuck</td>
<td>Treehouse</td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td></td>
<td>Blue Hole (weak)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Exurgence Vs. Resurgence

Unconfined Springshed

Saltwater/Freshwater Transition Zone
“Inner” Transition Zone (Ca-Mg-SO₄-HCO₃) Water
“Outer” Transition Zone (Na-Ca-Mg-Cl-SO₄) Water

Surficial aquifer system
Intermediate aquifer & confining system

Upper Floridan aquifer system
Confining Unit (Anhydrite & Gypsum-Rich)

Spring Protection Area
Springshed Protection Area
Surface Water Protection Area

Spring

Figure 55. Relative position of rock matrix and saline analytes in the Upper Floridan aquifer system.
Santa Fe River Swallet and Rise
• Dye tracer studies have demonstrated conduits which connect surface the Mill and Cellon creek watersheds to Hornsby Spring via sinks.
• River Rise and Columbia are also connected to other sinks.
Nitrate Vs. K – Multiple Springs
## Nitrate and Potassium (K)

<table>
<thead>
<tr>
<th>Nitrate Correlation with K</th>
<th>Nitrate Trend Over Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
</tr>
<tr>
<td>Positive</td>
<td>Ruth / Little Sulfur, Convict, Manatee, Fanning, Ginnie, Rock Bluff</td>
</tr>
<tr>
<td>None</td>
<td>Gilchrist Blue, Hart</td>
</tr>
<tr>
<td>Negative</td>
<td>Madison Blue</td>
</tr>
</tbody>
</table>
Concluding Thoughts

• Need to better understand source(s) of water and nutrients
  • Delineate springsheds (and watersheds)
  • Identify karst features (sinks, caves, conduits)
  • Measure flow reversals
• Need to understand aquifer denitrification rates, limiting conditions
• Look for opportunities to recharge aquifers with clean water... PROJECTS PROJECTS PROJECTS PROJECTS
Questions As You Watch the Santa Fe River Swirl Into the Aquifer?

Santa Fe River Sink, O'Leno State Park by Dan M. Rountree
Thank you!

Ann B. Shortelle, Ph.D., Executive Director
shortelle_a@srwmd.state.fl.us
386.362.1001