Characterization of Stream Flow in South Florida
Application to Managing Flow in Artificial Tributaries

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Florida Bay and Adjacent Marine Systems Conference
December 9, 2008
Historical Tributaries to Biscayne Bay

- Historical maps and charts indicate many persistent streams in the Biscayne Bay Watershed.

- Examples:
  - Snake Creek
  - Arch Creek
  - Little River
  - Miami River
  - Cutler Creek
  - Black Creek
  - Marsh Creek (Turkey Pt)

Laurie and Whittle 1794
Freshwater vegetation occurred much closer to shorelines.

Estuarine species such as Eastern oysters were common along shorelines.
Runoff in Many Areas in South Florida are Managed by Canals

- Most of the drainage along the southeast coast is now managed.
- Hydrologic patterns typically possess high peak flows, no flow and few low flows.
What Were the Runoff Patterns in the Original Rivers and Creeks?

- Do present-day analogs still exist?
- Can the flow patterns of existing streams be described in practical mathematical terms?

Miami River and Miami Canal 1920
South Florida location minimizes topographic and climatic differences.

Selected 7 rural tributaries with a range of mean flows:

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Station Name</th>
<th>Daily Mean Flow (CFS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kitching Creek</td>
<td>KITCHING</td>
<td>16</td>
</tr>
<tr>
<td>Taylor Creek</td>
<td>GRASSY</td>
<td>41</td>
</tr>
<tr>
<td>Boggy Creek</td>
<td>BOGGY.TA</td>
<td>63</td>
</tr>
<tr>
<td>Reedy Creek</td>
<td>REEDYLOU</td>
<td>69</td>
</tr>
<tr>
<td>Shingle Creek</td>
<td>SHINGLE.AP</td>
<td>83</td>
</tr>
<tr>
<td>Loxahatchee River</td>
<td>LNHRT</td>
<td>94</td>
</tr>
<tr>
<td>Arbuckle Creek</td>
<td>ARBUCK</td>
<td>309</td>
</tr>
</tbody>
</table>
Examine Flow Duration Curve Patterns

Flow duration curves produced.

Curves exhibited two distinct patterns:
- “normal” flows (flatter)
- “peak” flows (sharply rising)

Arbuckle Creek Flow Duration Curve
Create Flow Duration Curves

Bottom 80% of mean daily flow values plotted.
Observations About Flow Curves

- Flow is almost never 0.
- Curve inflection gentle.
- Curves appear similar for different streams and a range of flows.
Linear, quadratic and cubic curves tested.

Best fits were cubic.

$R^2$ values range from 0.978 to 1.000.

Flow duration curves can be simulated using cubic equations in “normal” range of flows.
Flow duration curves for Black Creek Canal (C-1)

Mean = 80.2 CFS
Conclusions About Modeled Flow Curves

- Natural, non-peak flow duration curves can be predicted with simply polynomials.
- Excellent fits to cubic regressions.
- The cubic model applies to a large range of stream flows.
- Daily mean flows are rarely equal to zero.
- The distribution of natural flows v. canal (managed) flows is less variable.
- A “preferred” or more natural hydrograph can be simulated for canal flows (or any stream).
- Will not give a “targeted” quantity of water, but may give targeted pattern of flow.
What does this mean about estuarine habitat?

- Salinity patterns will necessarily be different if canal flows simulated natural stream flows into the estuary.
- How different?
- Test case at Black Creek Canal (C-1).
Salinity at Mouth of Black Creek Canal

- M-D DERM monitored salinity monthly (1 M depth) 1979-2007; 283 obs.
- Salinity ranged from 0 to 40 psu.
Flow/ Salinity Relationship at Mouth of Black Creek Canal

- A model allows the use of the entire flow record for hindcasting and power (8803 pairs).
- Some buffering effect: Used 5-day mean flow.
- Relationship to flow: Cubic Regression; \( R^2=0.60 \) (lowest 80% of flow values)
- Other important variables likely wind, tide, temperature.
Simulated Salinity Based on Existing and Preferred Flows at Black Creek (1978-2008)

- If the existing Black Creek Canal flow pattern was manipulated to resemble a more natural hydrographic curve, salinity near the mouth in Biscayne Bay would be a more stable estuarine habitat.

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Actual Flow (CFS)</th>
<th>Preferred Flow (CFS)</th>
<th>Observed Salinity (psu)</th>
<th>Simulated Salinity from Actual Flow (psu)</th>
<th>Simulated Salinity from Preferred Flows (psu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>80.2</td>
<td>80.2</td>
<td>21.5</td>
<td>21.6</td>
<td>20.3</td>
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<tr>
<td>St. Deviation</td>
<td>85.0</td>
<td>48.5</td>
<td>8.6</td>
<td>6.7</td>
<td>3.8</td>
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<tr>
<td>Range</td>
<td>326</td>
<td>211</td>
<td>41.0</td>
<td>25.3</td>
<td>16.8</td>
</tr>
<tr>
<td>% Between 15-25 psu</td>
<td>-</td>
<td>-</td>
<td>34</td>
<td>35</td>
<td>63</td>
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</table>