Developing Management Level Nutrient Targets and Thresholds for Southwest Florida Tidal Creeks

Presentation to the National Water Quality Monitoring Conference

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Multiple Project Goals

- **Grantor (EPA Wetlands Program Development Grant)**
  Accelerate research on wetlands

- **National Estuary Programs/Stakeholders**
  Develop management level nutrient targets and thresholds for tidal creeks

- **FDEP/ EPA Standards**
  Inform regulatory criteria for tidal creeks
Florida Nutrient Criteria Development

Hierarchy 1: (Site-specific)
- Level II Water Quality-Based Effluent Limitations,
- Nutrient Total Maximum Daily Loads,
- Site Specific Alternative Criteria,
- Reasonable Assurance Plans,
- Estuary-specific Criteria

Hierarchy 2: Lakes/Springs
- Stressor-Response Relationships (lakes & springs)

Hierarchy 3: Streams
- Reference-based thresholds (streams)
- combined with biological data (flora and fauna)

Hierarchy 4: Narrative
- Ditches/canals used for water conveyance,
- wetlands, non-perennial streams, tidally fluctuating areas, and
- South Florida flowing waters
 Classification and Selection
(16 creeks sampled)

Creek Classification and Selection

N=306
Sampling Design

Study Area

0F
Fresh

WQ Sample

Fish sample <1.5m depth and composite benthic chl a sample <1.0m depth

3 Strata

3M
Open Estuary
Snook Statistics

Tampa Bay Tidal Rivers

Length Frequency Histogram
Commonname=Common snook

Tidal Rivers

Tampa Bay Tidal Rivers

Geometric mean CPUE with 95% CI

Standard Length (mm)
Current Narrative Thresholds

Dissolved Oxygen and Chlorophyll $a$

**Surrogate Endpoints**

- Nutrients
- Chl $a$
- DO
- Fish/Benthos

**Stressor**

**Response Endpoints**

**Adverse Effects**
Narrative Standards

Estuarine DO Evaluation

Estuarine Chl a Evaluation

= Class C : most undeveloped creeks
General Nutrient Management Model

- Nutrients
  - Chla
  - DO
  - Fish/Benthos

Stressor → Nutrients → Chla → DO → Fish/Benthos

Response Endpoints: Nutrients → Chla

Adverse Effects: DO → Fish/Benthos
General Nutrient Management Model

Stressor -> Nutrients -> Chla -> DO -> Fish/Benthos

Response Endpoints: Chla, DO

Nutrients: Nutrients, Chla

Fish/Benthos: Fish/Benthos, Adverse Effects
IS EVERYTHING OK?

NO

Yes

Have a margarita!
Conditional Inference

Node 3 (n = 37)

Node 5 (n = 92)

Node 6 (n = 121)

Node 7 (n = 36)

\[ \text{H2o_UAL} \quad p < 0.001 \]

\[ \text{tn_mgl} \quad p < 0.001 \]

\[ \leq 2667.712 \]

\[ > 2667.712 \]

DO

% Sat

Node 3 (n = 37)

Node 5 (n = 92)

Node 6 (n = 121)

Node 7 (n = 36)

{High Poly, Oligohaline, Polyhaline}

Mesohaline

\{High Poly, Oligohaline, Polyhaline\}
Habitat Interactions

50m Buffer Attributes
- LDI
- % Urban / % Natural
- USF Canopy Cover
- Number of veg species

Instream Attributes
- USF Bathymetry
- USF Bottom Hardness
- FIM Habitat
- Water Quality
  - DO
  - Salinity
  - Temp
  - Chl a
  - Turbidity
  - TN
- NH₃
- NO₂+NO₃
- Conductivity
- TKN
- Orthophosphate
- TP

Instream Biological Responses
- Dissolved Oxygen
- Nutrients
- Water Column and Benthic Chlorophyll
- Ratio of Water Column/Benthic Chlorophyll

Watershed Attributes
- Nutrient/Hyd Loads
- Soils
- Elevation
- LDI
- Acres of Ag -Golf
- Impervious Area
- Stormwater Treatment
- Road Density
- Distance to Nearest Pass
- Bed Sediment Phosphorus
- USF- # Observed Outfalls
<table>
<thead>
<tr>
<th>Response Variable</th>
<th>Predictor</th>
<th>Percent of Variance explained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water column average (DO % sat)</td>
<td>CDOM 345, TN, OPO4, H2O_UAL, Natural Buffer Proportion, Salinity Class</td>
<td>42.03%</td>
</tr>
<tr>
<td>Water Column Chlorophyll</td>
<td>TKN, TN, NH3, OrgP, Turbidity, Natural Buffer Proportion</td>
<td>46.84%</td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>TP, CDOM, Turbidity, OPO4, OrgP, Proportion of agriculture in the buffer, Acreage of golf course in the watershed, Natural buffer proportion, and the number of outfalls in the surveyed portion of the creek</td>
<td>69.97%</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>Creek Length, TN, Proportion of agriculture in the buffer, TKN, Acreage of golf course in the watershed, Natural buffer proportion, and the number of outfalls in the surveyed portion of the creek</td>
<td>84.24%</td>
</tr>
<tr>
<td>Benthic Chlorophyll (BMAC)</td>
<td>Salinity, OPO4, CDOM, Natural buffer proportion, Creek length, TP, and NH3</td>
<td>20.27%</td>
</tr>
<tr>
<td>Chlorophyll Ratio</td>
<td>TKN, TN, NH3, NO23, Turbidity, Natural buffer proportion, OPO4, TP, and CDOM</td>
<td>34.05%</td>
</tr>
</tbody>
</table>
Mixing Curves/Nutrient Dynamics

Based on EPA 2012

Parameter=Total Nitrogen (mg/l)

Parameter=Total Phosphorus (mg/l)
Review of Findings

- Tidal creeks are critical habitat for estuarine dependent fish.
- The water quality was characteristic of wetland environments.
- Existing DO and Chlorophyll criteria not reliable indicator of nutrient impairment in southwest Florida tidal creeks.
- Tidal portion can contribute nutrients to the system.
- Unclear if addition is natural or anthropogenic.
- Observed nutrient levels have not yet resulted in highly eutrophic or dystrophic conditions in sampled creeks.
The Reference-Based Approach

Setting Targets and Thresholds in the Absence of an Observed Adverse Effect
Computer Simulation

<table>
<thead>
<tr>
<th>Stewardship Goals</th>
<th>Management Thresholds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Caution Level</td>
</tr>
<tr>
<td></td>
<td>Management Action Plan</td>
</tr>
<tr>
<td></td>
<td>Regulatory Threshold</td>
</tr>
</tbody>
</table>

1.65 Standard
Example Application of Management Strategy

Tampa Bay

Charlotte Harbor
Benefits of Management Strategy

- Includes stewardship, management and regulatory components.
- Based on observed, locally derived data.
- Includes nutrients, not just assumptions about DO/Chla and nutrients.
- Provides early detection mechanism with associated management responses.
- Provides a mechanism to further NEP CCMP goals.
- Encourages more science as basis for improving site-specific targets.
• Recognize that tidal creeks are wetland environments.

• Investigate interaction between source water, wetland vegetation, organic decomposition, and nutrients.

• Analyze data from larger tidal rivers to understand larger systems with longer time series of data.

• Develop and test nekton indices that can be used to evaluate creek condition as habitat.
Thanks!
END
The Eutrophication Paradigm

Comparative Evaluation of Fishery Response to Nutrients

<table>
<thead>
<tr>
<th>Oligotrophic (low productivity)</th>
<th>Mesotrophic (medium productivity)</th>
<th>Eutrophic (high productivity)</th>
<th>Dystrophic (no productivity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE North Sea</td>
<td>N. Gulf of Mexico</td>
<td>N. Adriatic Sea</td>
<td>Great Lakes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Kattegat</td>
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<tr>
<td></td>
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<td>Baltic Sea</td>
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<td>Seto Inland Sea</td>
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<tr>
<td></td>
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<td></td>
<td>Yellow Sea</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NW Black Sea</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Chesapeake Bay</td>
</tr>
</tbody>
</table>

Source: Redrawn from Gaffney 1993.
Example of Potential Integration into Planning/Verified List

<table>
<thead>
<tr>
<th>WBID</th>
<th>Water Segment Name</th>
<th>Water-body Type</th>
<th>Water-body Class</th>
<th>Parameters Assessed Using the Impaired Waters Rule (IWR)</th>
<th>Concentration of Criterion or Threshold Not Met</th>
<th>NEP Action Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1507A</td>
<td>Rocky Creek</td>
<td>Estuary</td>
<td>3M</td>
<td>Nutrients (Historic Chlorophyll-a)</td>
<td>Median TN = 1.35 mg/L</td>
<td>Red</td>
</tr>
<tr>
<td>1507A</td>
<td>Channel A</td>
<td>Estuary</td>
<td>3M</td>
<td>Nutrients (Chlorophyll-a)</td>
<td>Median TN = 1.14 mg/l</td>
<td>Yellow</td>
</tr>
<tr>
<td>1530</td>
<td>Moccasin Creek</td>
<td>Estuary</td>
<td>3M</td>
<td>Nutrients (Chlorophyll-a)</td>
<td>Median TN = 0.94 mg/L</td>
<td>Green</td>
</tr>
<tr>
<td>1563</td>
<td>Lower Rocky Creek</td>
<td>Estuary</td>
<td>3M</td>
<td>Nutrients (Chlorophyll-a)</td>
<td>&gt; 11 µg/L</td>
<td>Yellow</td>
</tr>
<tr>
<td>1570A</td>
<td>Sweetwater Creek Tidal - Lower</td>
<td>Estuary</td>
<td>3M</td>
<td>Nutrients (Historic Chlorophyll-a)</td>
<td>Median TN = 1.21 mg/L</td>
<td>Green</td>
</tr>
<tr>
<td>1570A</td>
<td>Sweetwater Creek Tidal</td>
<td>Estuary</td>
<td>3M</td>
<td>Nutrients (Chlorophyll-a)</td>
<td>Median TN = 1.05 mg/l</td>
<td>Green</td>
</tr>
</tbody>
</table>
Number

Biomass