BIOLOGICAL - ENVIRONMENTAL CLASSIFICATION (BEC) SYSTEM AND SUPPORTING FLOW – BIOLOGY RELATIONSHIPS IN NORTH CAROLINA – PROJECT UPDATE

Conducted by: RTI and USGS

Funded by: Environmental Defense Fund, NC DENR, and NC WRC
BEC stream classification system:
• Do multifactor response models offer better predictions of biological response?
• Do a priori regional classifications improve strength of flow-biology relationships?

RTI IR&D flow-biology relationships:
• Riffle-run fish guild (normalized by basin)
• Wadeable streams in NC

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**Biological Condition (normalized species richness)**

**Annual Ecodeficit (%)**

- 50th Percent Species in Mountains
- 50th Percent Species in Piedmont
- 10% Reduction in Biologic Condition
- 20% Reduction in Biologic Condition
- 30% Reduction in Biologic Condition
BEC STREAM CLASSIFICATION

- Multifactor response models?
  - NC fish (species richness of riffle-run guild)
  - Flow metrics:
    - Summer Ecodeficit
    - decreases in Annual 30-day Minimum Flow
  - Best model fit:
    - Flow metric
    - Ecological Drainage Unit (EDU) regions
    - Slope
    - % Forest Cover (correlated with flow metric)
    - Average Temperature

NOTE: Results are similar for invertebrates
BEC STREAM CLASSIFICATION

- *A priori* regional classification improve strength of flow-biology relationship?
  - NC fish (species richness of riffle-run guild; RTI flow-biology methodology – normalized by basin; response of 90\textsuperscript{th} percentile data)
  - Flow-biology relationships by EDU
  - Results:
    - Flow-biology relationships were not consistently strengthened by splitting up by EDU
      - only 4 of 10 EDUs had significant flow-biology relationships
      - only 1 EDU had a better model fit than the state-wide model (Albemarle Pamlico Piedmont EDU)
RECOMMENDATION

• Use state-wide flow-biology relationships for fish and benthos (based on RTI flow-biology methodology) to support determination of ecological flows
  – Biological response:
    • Fish
      – Species richness of Riffle-run guild
      – Normalized by basin
    • Benthos
      – EPT Richness
      – Normalized by Omernik Level III
  – Flow metric:
    • Ecodeficit
Ecodeficit is a measure of the reduction in volumetric water availability.

- 20% ecodeficit = 20% reduction in volumetric water availability (over a defined period of time)
ANNUAL ECODEFICIT - FISH

- 90th Percent Species
- 10% Reduction in Biologic Condition
- 20% Reduction in Biologic Condition
- 30% Reduction in Biologic Condition
- 40% Reduction in Biologic Condition
- 50% Reduction in Biologic Condition

Biological Condition (Normalized Fish Species Richness - %)

Annual EcoDeficit - %

RTI INTERNATIONAL

USGS science for a changing world
Note: 50% reduction in biological condition is beyond the range of the data.
ANNUAL ECODEFICIT - COMBINED

- Benthic EPT Richness
- Fish Species Richness
### Annual Ecodeficit - Combined

- Annual versus seasonal ecodeficit – biological responses relationships and associated “biological condition” thresholds

<table>
<thead>
<tr>
<th>Metric</th>
<th>Fish: Species Richness</th>
<th>Benthos: EPTR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10%</td>
<td>20%</td>
</tr>
<tr>
<td>Annual EcoDeficit</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Winter Deficit</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Spring Deficit</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Summer Deficit</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Fall Deficit</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Average</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
WHAT’S NEXT?

- Depending on the current condition of a stream, how much degradation in the biological condition is EF-SAB (NCDENR) willing to tolerate?
RELEVANCE:
NEED TO LINK ECOLOGICAL
RESPONSES (E.G., EPT RICHNESS) AND
FLOW DEFICITS (I.E., QUANTILE
REGRESSIONS) TO ECOLOGICAL
CONDITION
DWQ HAS ESTABLISHED INVERTEBRATE CONDITION CLASSES BASED ON EPT TAXA RICHNESS

- DWQ uses EPT richness as one means of establishing condition classes:

<table>
<thead>
<tr>
<th></th>
<th>Mountain</th>
<th>Piedmont</th>
<th>Coastal Plain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>&gt;35</td>
<td>&gt;27</td>
<td>&gt;23</td>
</tr>
<tr>
<td>Good</td>
<td>28-35</td>
<td>21-27</td>
<td>18-23</td>
</tr>
<tr>
<td>Good-Fair</td>
<td>19-27</td>
<td>14-20</td>
<td>12-17</td>
</tr>
<tr>
<td>Fair</td>
<td>11-18</td>
<td>7-13</td>
<td>6-11</td>
</tr>
<tr>
<td>Poor</td>
<td>0-10</td>
<td>0-6</td>
<td>0-5</td>
</tr>
</tbody>
</table>

- DWQ has condition rankings for most sites and dates used in EF-SAB analyses
THEREFORE, WE CAN CALCULATE 90\textsuperscript{TH} PERCENTILE FOR CONDITION CLASSES IN EACH ECOREGION

Mountains: 66 (Blue Ridge), Piedmont: 45, Coastal Plain: 63 (Mid Atlantic Coastal Plain) + 65 (Southern Plain)
STANDARDIZE FOR 90TH PERCENTILE CONDITION IN EACH CONDITION CLASS WITHIN EACH ECOREGION
DERIVE STATE-WIDE CONDITION CLASSES BASED ON AVERAGE STANDARDIZED VALUES
### STATE-WIDE CONDITION CLASSES BASED ON 90TH PERCENTILE

<table>
<thead>
<tr>
<th>Category</th>
<th>EPT richness¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>≥ 0.868</td>
</tr>
<tr>
<td>Good</td>
<td>0.868 - 0.675</td>
</tr>
<tr>
<td>Good-Fair</td>
<td>0.675 - 0.469</td>
</tr>
<tr>
<td>Fair</td>
<td>0.469 - 0.249</td>
</tr>
<tr>
<td>Poor</td>
<td>&lt; 0.249</td>
</tr>
</tbody>
</table>

¹EPT taxa richness scaled by 90th percentile in mountains, Piedmont, and Coastal Plain

Screening criteria: if a planned water withdrawal results in a flow deficit (annual, summer, winter, etc.) that pushes the site into a lower condition class then a site-specific flow-ecology study is warranted (e.g., PHABSim).
STATE-WIDE CONDITION CLASSES BASED ON 90TH PERCENTILE

Note: Thresholds for Good-Fair to Fair and Fair to Poor are not reached within 100% decrease in Annual EcoDeficit
ADVANTAGES OF APPROACH

• Data-driven approach for establishing ecological flows
• Relates back to NC DWQ concept of biological condition classes
• Uses state-wide flow-biology relationships for fish and benthos (based on RTI flow-biology methodology) to support determination of ecological flows
• Guards against further degradation, while taking into account of current conditions
• On-going process (adaptive management)