Evaluating Macroinvertebrate Metrics from Low Gradient Stream Habitat in Connecticut

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Connecticut Department of Energy and Environmental Protection
Outline

• History of Low Gradient

• 2011 - 2016 Sampling

• Testing Metrics

• Next Steps
What is Low Gradient (LG)?

- Low slope
- Low velocity
- No (or very few) riffles
- Likely to meander
History of Low Gradient Sampling in CT

  - Not part of dataset – did not follow same sampling protocols (i.e. 2 sand)
- No current method for assessing LG waters besides chemistry
- High Gradient (HG) Multi-Metric Index (MMI) developed in 2007
Site Selection

- Site list compiled from staff insight
- Wadeable
- Non-tidal
- Perennial
- Defined Stream Channel
Sampling Methodology - Benthos

- A multi-habitat approach across 100 m reach
- 500 micron mesh D-frame net
- 20 total jabs/sweeps
  - 1m length jab followed by 2-3 sweeps of suspended material
- 2 jabs - sand/fine sediment
- 18 jabs - based on % habitat present

<table>
<thead>
<tr>
<th>Habitat</th>
<th>% Reach</th>
<th># Jabs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macrophytes</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>Woody debris</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>Undercut banks/roots</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>Rock</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>Sand/fine sediment</td>
<td>10%</td>
<td>2</td>
</tr>
</tbody>
</table>

- Habitat percentages:
  - Macrophytes: 24%
  - Rock: 36%
  - Sand/Fine Sediment: 10%
  - Undercut banks/roots: 1%
  - Woody Debris: 29%
Other Parameters

- **YSI Probe**
  - Temperature
  - Specific conductance
  - Total dissolved solids (TDS)
  - Dissolved oxygen (DO)
  - pH

- **Chemistry & Nutrients**
  - Nitrogen
  - Phosphorus
  - Chloride
  - Total suspended solids (TSS)
  - Hardness

- **Habitat**

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Narrowing Down Dataset

- 2011-2016 Sampling Effort ~ 95 samples
- Remove field and lab duplicates
- Remove samples without 20 jabs
- Remove same site samples from multiple years

FINAL DATASET = 62 samples
Quick Exploration

233 unique genera

Number of Genera per Sample

n = 62

Genera

- Physa
- Maccaffertium
- Microtendipes
- Hyalella
- Dubiraphia

% Occurrence
First Cut Reference Sites

Based off of % Impervious Cover (% IC)

n = 62

Reference n = 33
Intermediate n = 12
Degraded n = 17

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Chemistry supports using % IC
The 4 Types of Metrics

1. Composition / Abundance
2. Richness / Diversity
3. Sensitivity / Tolerance
4. Functional Metrics
   - Feeding Types
   - Habitat Preferences
   - Life Cycle

Discrimination Efficiency

- **Discrimination efficiency (DE):**
  level of separation between metric values of “reference” and “degraded” sites

- Range: 0 - 100
- Higher is better
- Criteria: DE > 75

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Mann-Whitney Test

• Mann-Whitney test:
  a non-parametric test used to assess whether observations in one sample (i.e. reference sites) differ from observations of another sample (i.e. disturbed sites)

• Criteria: p-value < 0.05
# Building Metrics

<table>
<thead>
<tr>
<th>Metric_Name</th>
<th>DE</th>
<th>MannWhit_pvalue</th>
</tr>
</thead>
<tbody>
<tr>
<td>% E</td>
<td>100</td>
<td>0.00001</td>
</tr>
<tr>
<td>% EPT</td>
<td>94.12</td>
<td>0.00013</td>
</tr>
<tr>
<td>% EPT (Sensitive)</td>
<td>94.12</td>
<td>0.00016</td>
</tr>
<tr>
<td>% AI (minus genus Hyalella)</td>
<td>88.24</td>
<td>0.00770</td>
</tr>
<tr>
<td>% EOT</td>
<td>88.24</td>
<td>0.00035</td>
</tr>
<tr>
<td>% ET</td>
<td>88.24</td>
<td>0.00001</td>
</tr>
<tr>
<td>% A (minus Hyallela)</td>
<td>82.35</td>
<td>0.00441</td>
</tr>
<tr>
<td>ET Richness</td>
<td>82.35</td>
<td>0.00869</td>
</tr>
<tr>
<td>Sensitive EPT Richness</td>
<td>82.35</td>
<td>0.00339</td>
</tr>
<tr>
<td>EOT Richness</td>
<td>76.47</td>
<td>0.00698</td>
</tr>
<tr>
<td>EPT Richness</td>
<td>76.47</td>
<td>0.01852</td>
</tr>
</tbody>
</table>

\*p-value shown = p \times 10^3

<table>
<thead>
<tr>
<th>Metric_Name</th>
<th>DE</th>
<th>MannWhit_pvalue</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Most Abundant Taxa (FAMILY)</td>
<td>64.71</td>
<td>0.00396</td>
</tr>
<tr>
<td>% Scrapers</td>
<td>64.71</td>
<td>0.00523</td>
</tr>
<tr>
<td>% T</td>
<td>64.71</td>
<td>0.02559</td>
</tr>
<tr>
<td>Shannon Diversity Index (FAMILY)</td>
<td>64.71</td>
<td>0.00072</td>
</tr>
<tr>
<td>Taxa Richness (FAMILY)</td>
<td>64.71</td>
<td>0.00035</td>
</tr>
<tr>
<td>Scrapers Richness</td>
<td>58.82</td>
<td>0.00585</td>
</tr>
<tr>
<td>Predators Richness</td>
<td>52.94</td>
<td>0.00919</td>
</tr>
<tr>
<td>% Collectors - Gatherers</td>
<td>47.06</td>
<td>0.05904</td>
</tr>
<tr>
<td>% Most Abundant Taxa (GENUS)</td>
<td>47.06</td>
<td>0.06382</td>
</tr>
<tr>
<td>% Shredder</td>
<td>47.06</td>
<td>0.08929</td>
</tr>
<tr>
<td>% Collectors - Filterers</td>
<td>41.18</td>
<td>0.26874</td>
</tr>
<tr>
<td>Collectors - Filterers Richness</td>
<td>41.18</td>
<td>0.06078</td>
</tr>
<tr>
<td>Shannon Diversity Index (GENUS)</td>
<td>41.18</td>
<td>0.04621</td>
</tr>
<tr>
<td>Taxa Richness (GENUS)</td>
<td>41.18</td>
<td>0.06058</td>
</tr>
<tr>
<td>% of Top 3 Taxa</td>
<td>41.18</td>
<td>0.05551</td>
</tr>
<tr>
<td>% of Top 5 Taxa</td>
<td>41.18</td>
<td>0.02891</td>
</tr>
<tr>
<td>% Predators</td>
<td>35.29</td>
<td>0.40491</td>
</tr>
<tr>
<td>Collectors - Gatherers Richness</td>
<td>35.29</td>
<td>0.03666</td>
</tr>
<tr>
<td>% D</td>
<td>23.53</td>
<td>0.90322</td>
</tr>
<tr>
<td>% O</td>
<td>23.53</td>
<td>0.88585</td>
</tr>
<tr>
<td>% DC</td>
<td>17.65</td>
<td>0.71239</td>
</tr>
<tr>
<td>Shredders Richness</td>
<td>17.65</td>
<td>0.77858</td>
</tr>
</tbody>
</table>

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% EPT (Ephemeroptera, Plecoptera, & Trichoptera)

• Type 1: Composition / Abundance

[Graphs showing the relationship between % Impervious Cover (IC) and Pct_EPT, and box plots for different levels of water quality: Reference (n = 33), Intermediate (n = 12), and Degraded (n = 17).]
% Al (Amphipoda & Isopoda w/out genus Hyalella)

- Type 1: Composition / Abundance
EOT Richness (Ephemeroptera, Odonata, & Trichoptera)

- Type 2: Richness / Diversity
% Filterer (Ephemeroptera, Trichoptera, Diptera)

- Type 4: Functional
Shannon Diversity Index (genus)

- Type 2: Richness / Diversity
Lessons Learned

1. Using R is the way to go

2. Metrics can be regionally specific
Next Steps

1. Gather sensitivity/tolerance data
2. Build more metrics
3. Add chemistry/other parameters for reference site determination
4. Retest duplicate data that was left out
5. Possibly split dataset into “true” LG and hybrid LG
6. Assess need for additional sampling
   o Additional disturbed sites?
Questions?

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