Where the Surber Stops: Groundwater Communities Below the Stream Bed

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Surface Water Quality Monitoring Workshop, November 3, 2016
Aquatic Biology is Shallow

- Biomonitoring efforts
  - Biodiversity patterns
- Surface vs. groundwater regulation
Biodiversity and rarity

• 150 of 449 ‘Species of Greatest Conservation Need’

http://tpwd.texas.gov/huntwild/wild/wildlife_diversity/nongame/tcap/sgcn.phtml
Why care about groundwater taxa?

- **Aquatic**: 17 (33%)
- **Terrestrial**: 19 (37%)
- **Groundwater obligate**: 5 (10%)
- **Groundwater dependent**: 10 (20%)
Texas groundwater fauna

• 64 invertebrate species
  • (91% state endemics)
  • Diverse origins

Photo: J. Krejca, Zara Environmental LLC
Species richness by county
Conservation Status Ranks

NatureServe Methodology

<table>
<thead>
<tr>
<th>Factor Category</th>
<th>Weight</th>
<th>Factor</th>
<th>Factor Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rarity</td>
<td>0.7</td>
<td>Range Extent</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Area of Occupancy</td>
<td>2</td>
</tr>
<tr>
<td>Threats</td>
<td>0.3</td>
<td>Population Size</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of Occurrences</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of Secure Occurrences</td>
<td>2</td>
</tr>
<tr>
<td>Threats</td>
<td>0.3</td>
<td>Threat Impact</td>
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</table>

Value Range for Calculated Score

<table>
<thead>
<tr>
<th>Calculated Score</th>
<th>Status Rank</th>
<th>Status Description</th>
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</thead>
<tbody>
<tr>
<td>score ≤1.5</td>
<td>S1</td>
<td>Critically imperiled</td>
</tr>
<tr>
<td>1.5&lt; score ≤2.5</td>
<td>S2</td>
<td>Imperiled</td>
</tr>
<tr>
<td>2.5&lt; score ≤3.5</td>
<td>S3</td>
<td>Vulnerable</td>
</tr>
<tr>
<td>3.5&lt; score ≤4.5</td>
<td>S4</td>
<td>Apparently secure</td>
</tr>
<tr>
<td>score &gt;4.5</td>
<td>S5</td>
<td>Secure</td>
</tr>
</tbody>
</table>

Faber-Langendoen et al., 2012
“Whiskey is for drinking…”

- Threats
  - Water extraction
  - Domestic & urban effluents
  - Oil & gas
  - Farming & ranching
  - Agricultural effluents
Rarity

Trontelj et al., 2009; Deharveng et al., 2009; Everhard et al., 2008
Threats
Results

<table>
<thead>
<tr>
<th>Status Rank</th>
<th>Number of Species</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>20</td>
<td>33%</td>
</tr>
<tr>
<td>S2</td>
<td>15</td>
<td>23%</td>
</tr>
<tr>
<td>S3</td>
<td>12</td>
<td>28%</td>
</tr>
<tr>
<td>S4</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>S?</td>
<td>4</td>
<td>14%</td>
</tr>
</tbody>
</table>
Beetles & Snails
Ponder & Colgan (2002)

- 12 spp.
- 9 S1 – S2

- 8 spp.
- All S1

Barr et al., 2015
Looking deeper

Looking deeper (but not too deep)

Diagram of the Hyporheic Zone

Stream Channel

Unsaturated Zone (dry land)

Channel Water

Hyporheic Zone (Saturated)

Groundwater Zone

Impermeable Layer
Why is it important?

• Primary habitat
• Dispersal corridor
• Accessible & extensive
Hyporheic inventories in U.S.A.


Looking deeper (but not too deep)

Methods

• 22 sites
• 3 replicates * 2 visits
• 9L H2O filtered at 200 µm in 95% ETOH
• Physicochemistry, ions, δD + δ18O isotopes
• Samples sorted at 10X mag.
- RDA & permutation test \((F = 0.49 \ (1,12), \ p = 0.78)\)
NON KARST

- Ostracods: 24%
- Ephemerida: 12%
- Coleoptera: 4%
- Plecoptera: 9%
- Chironomidae: 11%
- Corethrellidae: 6%
- Cladocera: 5%
- Harpacticoids: 3%
- Acari: 2%
- Bivalvia: 1%
- Annelids: 8%
- Other: 3%
A pie chart showing the percentage distribution of different insect species in a karst environment.

- Chironomidae: 23%
- Ceratopogonidae: 2%
- Corethrellidae: 10%
- Chironomidae: 23%
- Lirceolus: 11%
- Ostracods: 6%
- Coleoptera: 2%
- Ephemoptera: 5%
- Crustacea (other): 3%
- Seborgia: 2%
- Diptera (other): 4%
- Other: 4%
- Annelids: 6%
- Phreatodrobia: 1%
- Harpacticoids: 3%
- Cyclopoids: 18%
- Other: 4%

Photo: J. Krejca
New Habitat

- Phreatodrobia sp.
- Phreatoceras taylori
- Texanobathynella sp.*
- Lirceolus cocytus
- Lirceolus hardeni
- Parabogidiella americana*
- Artesia subterranea
- Seborgia hershleri*
- Haideoporus sp.*
- Microcerberidae n. sp.
- Hadziidae n. sp.
- Stygobromus n. sp.
- Ingolfiellidae n. sp.

Photos: B. Hutchins, R. Gibson, P. Diaz
Taxonomy problem

Photos: B Schwartz; B Hutchins
Rio Grande oddities
Summary of fauna composition

- 18 stygobiont taxa
- 13 species first occurrence in hyporheic
- 4 range extensions
- 40 new stygobiont occurrence records
Discussion

• Hyporheic sampling is low hanging fruit

• Lack of systematic assessment in U.S.
  • Importance to stream ecology
  • Presence of globally rare/high priority species
  • Greater sampling opportunity
Thank You
Water chemistry signal unclear

- Heterogeneity
  - Physical
  - Chemical
  - Temporal

Linear models: $F = 2.82_{(5,20)}, p = 0.04, R^2 = 0.27$

What does it all mean?
Conclusions

- Karst is important
- Geography/geology is important

Thank You