Using Biological Indicators to Assess Water Quality of Freshwater Streams

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Water Quality
Assessing Water Quality

- Chemical analyses
- Biotic analyses
  - Microbes
  - Periphyton
  - Fish
  - Benthic Macroinvertebrates (BMIs)
Added Value of Biotic Measures

• Many BMIs are long-lived in the water and interact with the surrounding riparian habitat as adults
• Biological indicators of current and recent past impacts on a stream system
• Impacts upstream may be detected in the downstream BMI community
BMIs as Bioindicators

• Many organisms are sensitive to specific impacts
  – The presence or absence of certain organisms indicates specific conditions
• Complexity of the BMI community indicates the temporal stability of stream health
  – Trophic relationships
• A change in the BMI community over time implies a change within the system
• While we cannot measure every possible stressor, the state of the BMI community can act as the first alarm when stream health declines.
Southern California Index of Biotic Integrity (IBI)

- Ode et al. 2005
- Based on 275 sites in Southern California Ecoregions 6 & 8
- Based on 500 count of BMIs
- Screened 61 candidate metrics
- Identified seven metrics for inclusion in the IBI
BMIs

True Flies

Stoneflies

Caddisflies

Dragonflies
Sites sampled in 2012

- IBI change below -5
- IBI change between -5 and +5
- IBI change above +5

40 Kilometers
Cold Creek
Cold Creek Fuel Spill

- Cold Creek a small tributary of the Santa Ana River
- Relatively large spill, April 2013
  - 6,435 liters of diesel fuel and 14,558 liters of gasoline spilled into Cold Creek
- Clean-up response 24 hours after the spill
- Bioassessment contracted to the Stream Ecology and Assessment Laboratory at CSULB, Nov 2013
Clean-up efforts

- Containment dams with absorbent booms and pads
  - 0.2, 0.4, and 1.2 km downstream from the spill site
- Flushing of diesel and gasoline from the creek bed into containment dams
- Vacuuming of diesel and gasoline at the first containment dam
- Absorbent booms and pads changed out at the lower two containment dams
Cold Creek Sampling Design
Biological Indicators

Diatoms

Benthic Macroinvertebrates (BMIs)
Diatoms!!
Diatomaceous Earth

Everything you need to know about

DIATOMACEOUS EARTH

www.theprairiehomestead.com
Acknowledgements

Maryanne Horton and Raquel Santos (CNSM)
Stream Ecology and Assessment Laboratory
Past Graduate Students
  Marty Lewis and Lauren Fah
Current Graduate Students
  Robert Esquivel, Matt Schliebe, Eilleen Salas
  Jose Caprile, Fritz Rieman
Undergraduate Students
  Sergio Mendoza, Brina Kamae

Heather Boyd, Santa Ana Regional Water Quality Control Board
Table 3. Scoring ranges for seven component metrics in the SoCal B-IBI

<table>
<thead>
<tr>
<th>Metric score</th>
<th>Coleoptera taxa (all sites)</th>
<th>EPT taxa</th>
<th>Predator taxa (all sites)</th>
<th>% Collector individuals</th>
<th>% Intolerant individuals</th>
<th>% Noninsect taxa (all sites)</th>
<th>% Tolerant taxa (all sites)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>&gt;5</td>
<td>&gt;17</td>
<td>&gt;18</td>
<td>0–59</td>
<td>25–100</td>
<td>0–8</td>
<td>0–4</td>
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<tr>
<td>9</td>
<td>8</td>
<td>16–17</td>
<td>17–18</td>
<td>60–63</td>
<td>23–24</td>
<td>9–12</td>
<td>5–8</td>
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<tr>
<td>7</td>
<td>6</td>
<td>15</td>
<td>16</td>
<td>64–67</td>
<td>21–22</td>
<td>13–17</td>
<td>9–12</td>
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<tr>
<td>5</td>
<td>4</td>
<td>13–14</td>
<td>14–15</td>
<td>68–71</td>
<td>19–20</td>
<td>18–21</td>
<td>13–16</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>9–10</td>
<td>11–12</td>
<td>76–80</td>
<td>13–15</td>
<td>18–21</td>
<td>20–22</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>5–6</td>
<td>8–9</td>
<td>85–88</td>
<td>7–9</td>
<td>26–29</td>
<td>23–25</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>2–3</td>
<td>5–6</td>
<td>93–96</td>
<td>1–3</td>
<td>43–46</td>
<td>34–37</td>
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<tr>
<td>0</td>
<td>0</td>
<td>0–1</td>
<td>0–4</td>
<td>97–100</td>
<td>0</td>
<td>47–100</td>
<td>38–100</td>
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</tbody>
</table>

Note: Three metrics have separate scoring ranges for the two Omernik Level III ecoregions in southern coastal California region (6 = chaparral and oak woodlands, 8 = Southern California mountains).

Example for a site in Ecoregion 6

<table>
<thead>
<tr>
<th>Coleoptera</th>
<th>EPT</th>
<th>Predator</th>
<th>%Collectors</th>
<th>%Intolerant</th>
<th>%Noninsect</th>
<th>%Tolerant</th>
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<tbody>
<tr>
<td>5</td>
<td>11</td>
<td>7</td>
<td>89</td>
<td>7</td>
<td>7</td>
<td>2</td>
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<tr>
<td>8</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

These individual metric scores are summed = 43.
This value is out of 70 and represents the raw score.
The raw scored is adjusted to a value between 0 and 100. 43 X 10/7 = 61
Bray-Curtis Similarity Indices

\[
S = 100 \left( 1 - \frac{\sum |y_{i1} - y_{i2}|}{\sum y_{i1} + \sum y_{i2}} \right)
\]

<table>
<thead>
<tr>
<th></th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sp. A</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Sp. B</td>
<td>50</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Sp. C</td>
<td>3</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>Sp. D</td>
<td>1</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>Sp. E</td>
<td>7</td>
<td>70</td>
<td>0</td>
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</tbody>
</table>

Abs (y1 - y2)

<table>
<thead>
<tr>
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<tr>
<td>Sp. A</td>
<td>10</td>
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<td>Sp. C</td>
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<tr>
<td>Sp. D</td>
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<tr>
<td>Sp. E</td>
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<td>70</td>
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<tr>
<td>sum Yi</td>
<td>71</td>
<td>155</td>
</tr>
<tr>
<td></td>
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</tbody>
</table>

Site 1  Site 2

| Site 2 | 23.01 |
| Site 3 | 36.78 | 18.71 |