Longitudinal Spatial Patterns in Riverine Ecological Indicators in the Pacific Northwest; Implications for River Survey Design

Alan Herlihy, Robert Hughes, and Bill Gerth
Oregon State University, Corvallis
Project Objectives - RIVMAP

• Characterize ecological condition in boatable river length in seven Northwest Rivers
• Study spatial autocorrelation for typical bioassessment measures in rivers
• Target Rivers
  – 100-200 km boatable length
  – 20-120 m wide
Study Rivers
Summer 2006-2008
Sample Site Selection

- 20 sites per river
- EMAP systematic random sample
  - Spatially balanced
  - Not equal interval
- Can make estimates of condition for whole boatable river length

Sprague River
Indicators Measured

- Physical Habitat
- Macroinvertebrates
- Water Chemistry
- Fish
- Periphyton

Willamette River Grass Carp
Sample Reach Layout

• **Length** = 50 Times Mean Wetted Width
  – Range of 1–10 km Long Reaches

• **Set 11 Equidistant Transects** along Reach
  – Composite Macroinverts and Periphyton
  – Riparian Physical Habitat

• **Between Transects**
  – Habitat Thalweg Profile
  – Electrofish Alternating Banks
Field Sampling

Crew of 4
Electrofishing Raft
Habitat Raft
## Study Rivers

<table>
<thead>
<tr>
<th>River</th>
<th>Watershed Area (km²)</th>
<th>Survey Length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malheur</td>
<td>9,050</td>
<td>153</td>
</tr>
<tr>
<td>Willamette</td>
<td>28,900</td>
<td>231</td>
</tr>
<tr>
<td>Okanogan</td>
<td>21,200</td>
<td>109</td>
</tr>
<tr>
<td>Sprague</td>
<td>4,170</td>
<td>108</td>
</tr>
<tr>
<td>Umpqua</td>
<td>10,500</td>
<td>208</td>
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<tr>
<td>Chehalis</td>
<td>3,550</td>
<td>87</td>
</tr>
<tr>
<td>John Day</td>
<td>17,800</td>
<td>190</td>
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</table>
Physical Habitat
Water Chemistry

Malheur River
Fish

Umpqua River
Among-Site Fish Assemblage Similarity by Distance

• For each river, calculated Bray-Curtis similarity between all pairs of sites
• 190 pairs for 20 sites
• Calculated river distance between each pair
Willamette River
Similarity-Distance Relationship

- Continual Decline with Distance
  - Umpqua, Malheur
- Little/No Relationship
  - John Day, Okanogan
- Zonation
  - Willamette, Chehalis
- Initial Decline, then No Change
  - Sprague, Lower Chehalis ~25 km
  - Upper Willamette, ~50-100 km
Mantel Test

Compares strength of relationship between two dissimilarity matrices (Spearman r)

- Calculated Six Matrices
  - Fish, Macroinvertebrates, Periphyton
    - Bray-Curtis Distance, log (x+1)
  - River Distance (Euclidean)
  - Water Chemistry (Euclidean)
    - Total N,P, Cl, SO$_4$, Turbidity
  - Physical Habitat (Euclidean)
    - Substrate size, riparian disturbance, fast water habitat, fish cover
Malheur River - Mantel r

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Fish</td>
<td>1</td>
<td>--</td>
<td>--</td>
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<tr>
<td>Invert</td>
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<td>0.23</td>
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<td>0.48</td>
<td>0.63</td>
<td>0.32</td>
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<tr>
<td>Distance</td>
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<td>0.60</td>
<td>0.61</td>
<td>0.27</td>
<td>0.52</td>
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</tbody>
</table>
Fish – Environment Mantel correlations

Spearman r

Distance  Chemistry  Habitat

Malheur  Chehalis  John Day  Okanogan  Sprague  Umpqua  Willamette
Macroinvertebrate – Environment
Mantel correlations

![Bar chart showing correlations between macroinvertebrates and environmental factors (Distance, Chemistry, Habitat) for different regions (Malheur, Chehalis, John Day, Okanogan, Sprague, Umpqua, Willamette). The graph displays Spearman correlation coefficients ranging from 0.0 to 0.7.]
Diatom – Environment Correlations

![Bar chart showing correlations between diatom and environment factors]

- **Distance**: Spearman's $r$ values range from approximately 0.4 to 0.6.
- **Chemistry**: Spearman's $r$ values range from approximately 0.3 to 0.6.
- **Habitat**: Spearman's $r$ values range from approximately 0.2 to 0.5.

Legend:
- Malheur
- Chehalis
- John Day
- Okanogan
- Sprague
- Umpqua
- Willamette
Environment – Distance Correlations

Spearman r

Chem-Distance  Phab-Distance  Chem-Phab

-0.2 -0.1 0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7

Malheur  Chehalis  John Day  Okanogan  Sprague  Umpqua  Willamette
Conclusions

• Among river variability >> within river longitudinal variability
• No consistent pattern in longitudinal similarity among either rivers or indicators
• Longitudinal spatial patterns in fish species assemblages is different among the seven study rivers
  – Continuous, No relation, Zonation
• Within-river similarity higher than I thought
Acknowledgements

• Funded by EPA’s REMAP Program
• John Day sampling funded by NOAA
• Crew Chiefs
  – 2006, Hank LaVigne
  – 2007+2008, Jason Adams
• Physical Habitat, Phil Kaufmann, EPA
• Periphyton: Yangong Pan, Portland State