Derivation of nutrient criteria using existing community thresholds

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Water Quality Protection for Streams

- Characterize designated uses
  - e.g., Aquatic Life, Recreation
- Derive criteria to protect those uses
- Measure aquatic life use attainment based on compliance with numeric and/or narrative standards

### Physiochemical
- Metals (toxics)
- DO, pH, temperature (non-toxic)

### Biological
- macroinvertebrates
- fish
- algae/periphyton

### Nutrients
- nitrogen
- phosphorus
Question

- Nutrient criteria are derived with the specific goal of protecting aquatic life from negative effects of nutrients.
- Do measures of impairment based on the macroinvertebrate community and nutrient concentrations give the same answer? Should they?
  - Case Study: Nutrient criteria in Colorado
    - TN, TP
Macroinvertebrates As Indicators

- Changes in the macroinvertebrate community in response to nutrient enrichment have been documented
  - However, “changes” do not necessarily equal “impairment”

- Multi-metric indices (MMIs) to assess macroinvertebrate community health exist in many states
  - Used to determine “Attainment” or “Impairment” of Aquatic Life Use
How Stream Nutrient Criteria Have Been Derived:

1. Percentile of nutrient concentrations at reference sites
2. Observed vs. Expected Models
3. Estimate the biological “threshold” response to range of nutrient concentrations
4. Compare nutrient concentrations and biological condition at reference and stressed sites

- Results in nutrient criteria below which a stream is considered “Impaired” and above which a stream is considered “Attaining”
Colorado’s Nutrient Criteria:

- Colorado combined biological threshold response and reference stream approaches
- Quantile Regression was used to characterize the relationship between nutrient concentrations and MMI scores
  - Advantageous for wedge-shaped data
Example: Proposed TP criterion for Colorado streams

- Developed from 85th percentile of MMI values at reference site

- Then “allowable” 5% decline in acceptable condition based on MMI score
  - Using slope from quantile regression

- TP value set at that 5% decline value
Example: Proposed TP criterion for Colorado streams

- Many sites Attaining based on MMI scored but exceeding TP criterion
Example: Proposed TP criterion for Colorado streams

- Many sites Attaining based on MMI scored but exceeding TP criterion
- Many sites “impaired” based on MMI scored but meeting TP criterion
- TN criterion shows a similar relationship
Example: Proposed TP criterion for Colorado streams

- So, overprotective?
  - Perhaps, if basis for standard is attainment of MMI
  - And, given potential for conflicting results

- Alternative approach
  - Extending the quantile regression line out to the MMI attainment threshold
  - Accounts for confounding factors
  - But, underprotective?
Example: Monument Creek, Colorado

- Nutrient and macroinvertebrate relationships assessed in Monument Creek, CO
- Assessed using Colorado approach and alternative approach
Example: Monument Creek, Colorado

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<tr>
<th>Site</th>
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<th>MMI</th>
</tr>
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<tbody>
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<td>S-1</td>
<td>Attain</td>
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</tr>
<tr>
<td>S-2</td>
<td>Impair</td>
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Example: Monument Creek, Colorado

- So, when criteria don’t agree, which criteria supersedes the others for the protection of the Aquatic Life use?
- The key is “what are we protecting?”
- And, what is the best way to protect it?
Current practice in Colorado

- Colorado will list a segment as Impaired if any one sample dictates that listing

- Example, Clear Creek, CO
  - Multiple sites sampled on one river segment, all Attaining for MMI except one Impaired
  - That “piece” of the segment listed as Impaired
Discussion

- How should nutrient and community data be used for “threshold” development?
  - Linear regression does not appropriately describe the relationship for wedge-shaped data
  - What is the best method to avoid deriving criteria that are not under- or over-protective?
Discussion

- When the goal is to protect Aquatic Life, should MMI criteria supersede other (e.g., nutrient, physiochemical) criteria?
  - If MMI scores indicate Attainment, is it appropriate to say that the stream is not attaining an aquatic life use based on other criteria?
  - Should a weight of evidence approach be used when listing stream segments?
    - i.e., if many sites are Attaining, but one is Impaired, should the segment be listed?
Questions?

Acknowledgements
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