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Derivation of nutrient criteria using existing community thresholds

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GEI Consultants

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
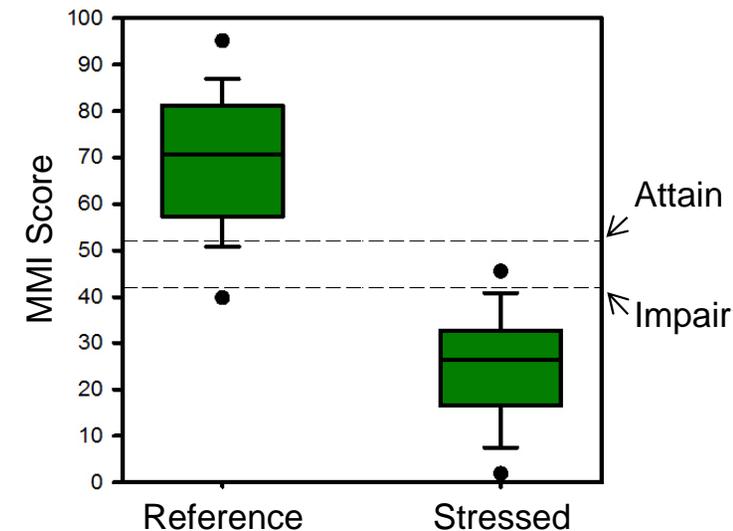
Nutrients
- nitrogen
- phosphorus

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"**
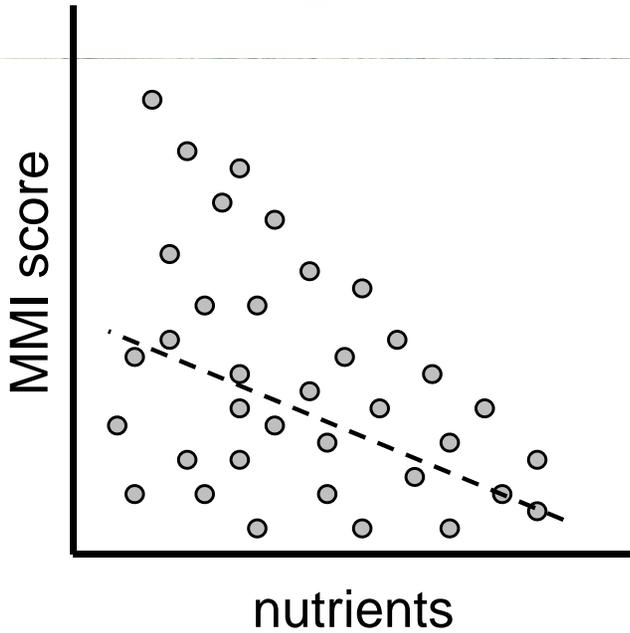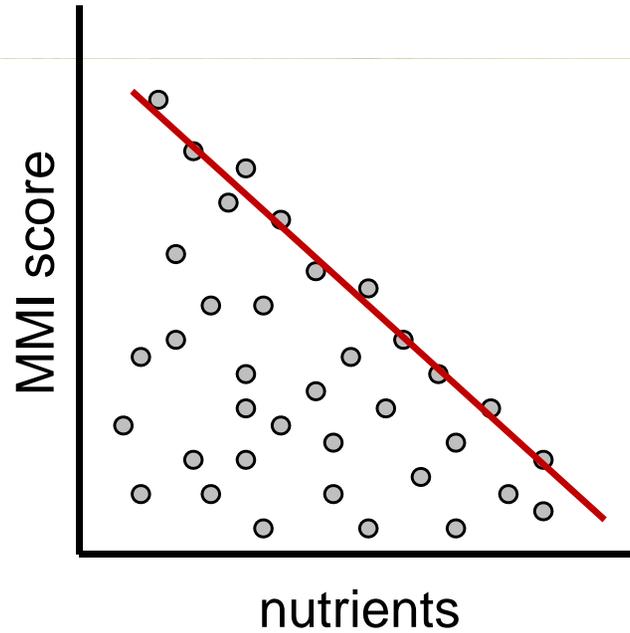

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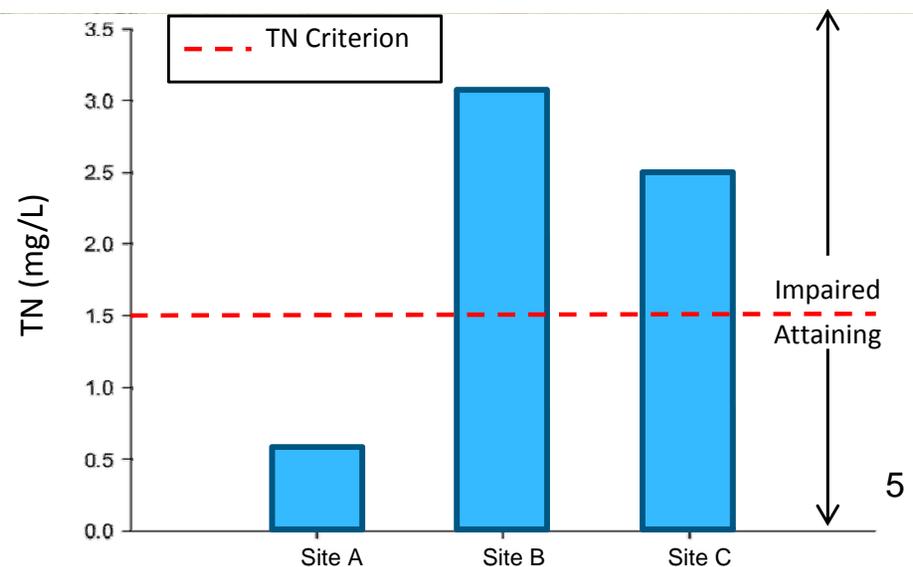
Colorado's Nutrient Criteria:

- **Colorado combined biological threshold response and reference stream approaches**

- **Quantile Regression was used to characterize the relationship between nutrient concentrations and MMI scores**
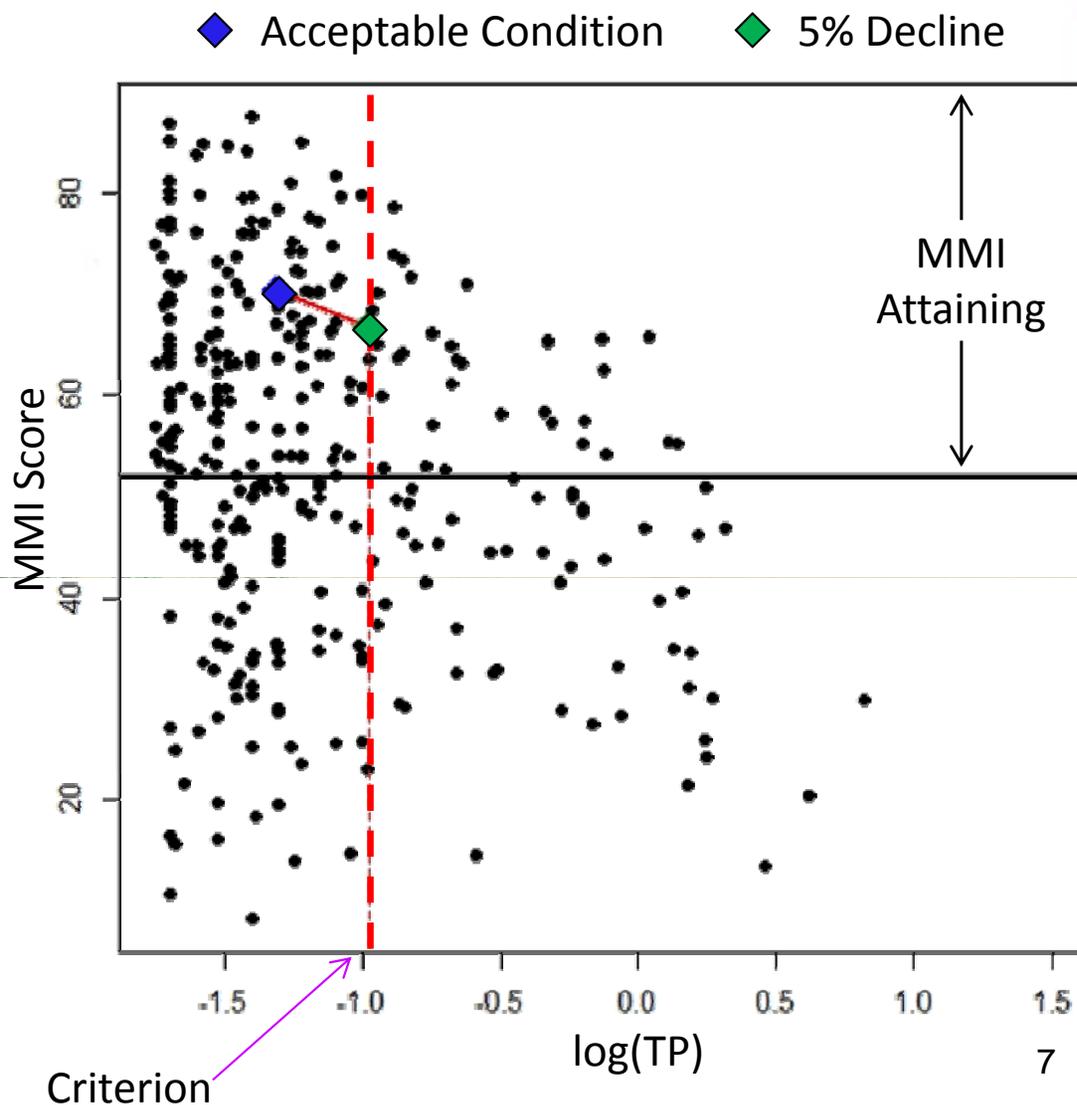 - Advantageous for wedge-shaped data

Linear Regression

Quantile Regression

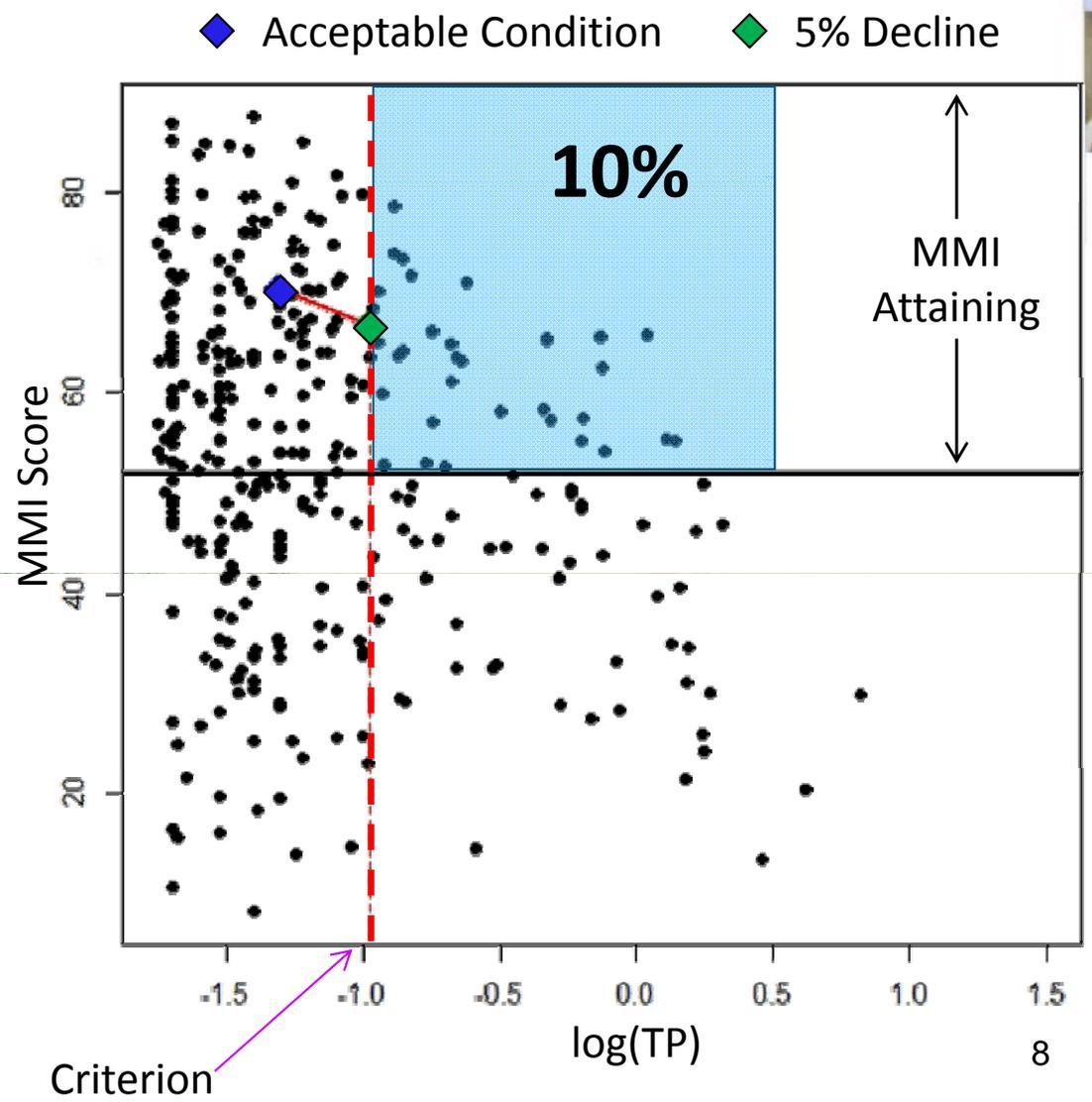# Example: Proposed TP criterion for Colorado streams

- **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**

Acceptable Condition   5% Decline

MMI Attaining

MMI Score

log(TP)

Criterion
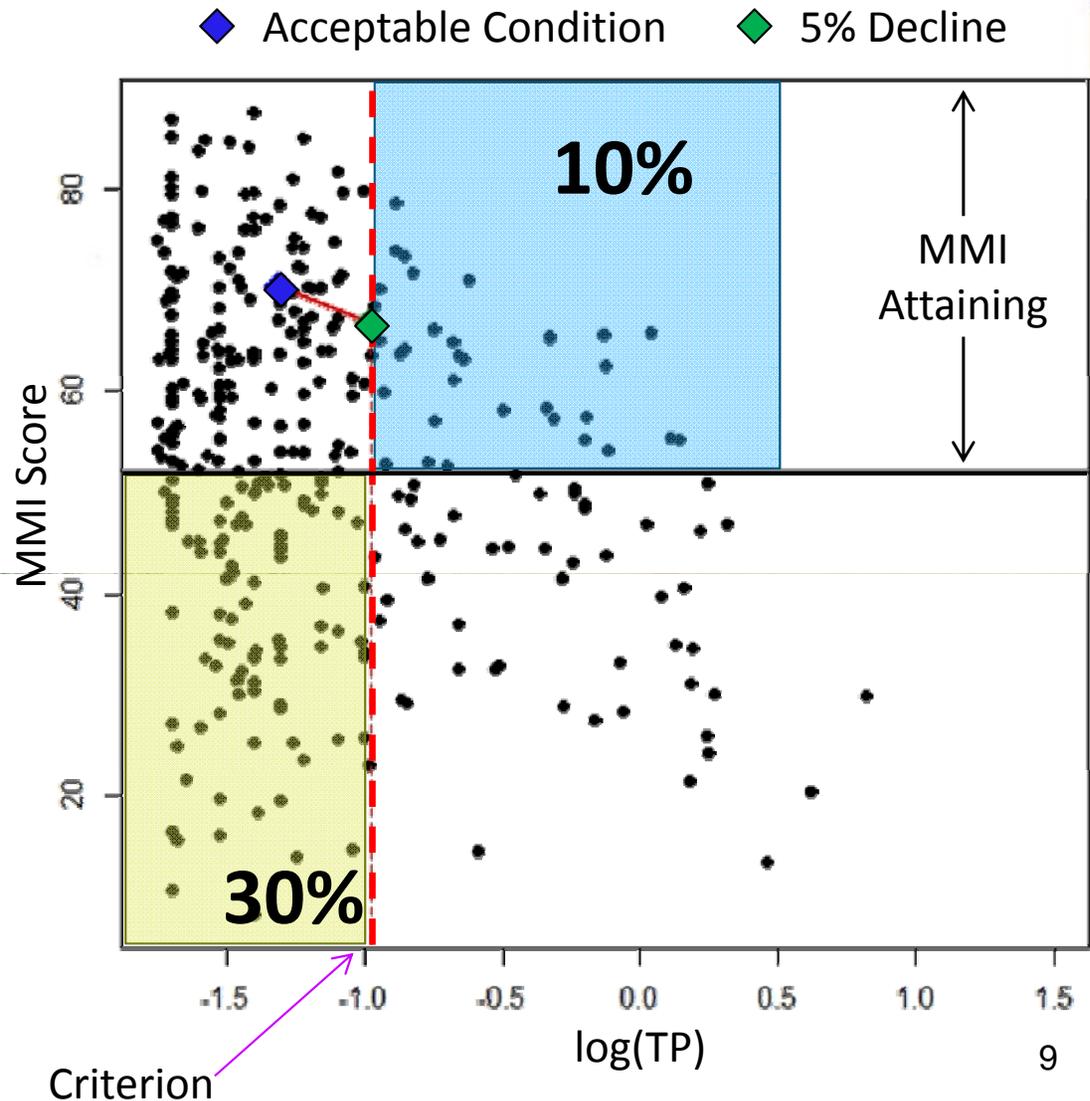
Example: Proposed TP criterion for Colorado streams

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- **Many sites Attaining based on MMI scored but exceeding TP criterion**

Example: Proposed TP criterion for Colorado streams

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- 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

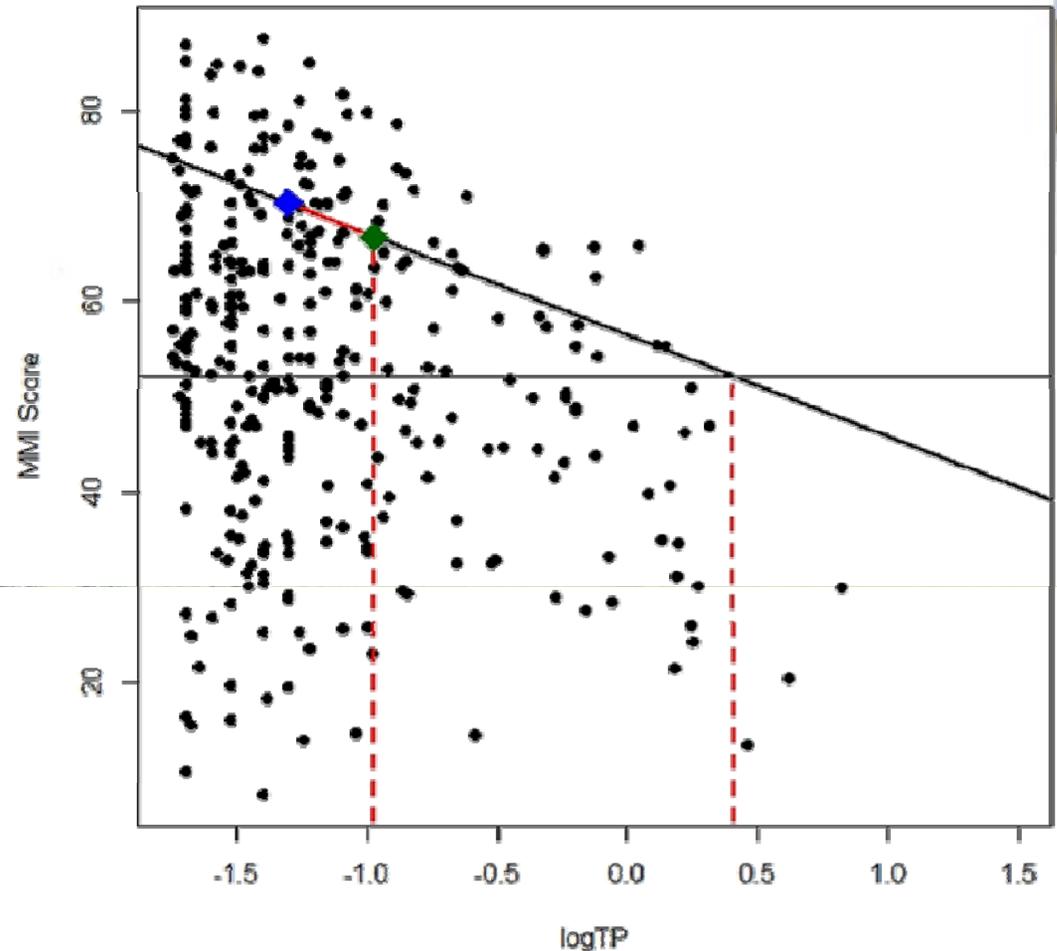# Example: Proposed TP criterion for Colorado streams

- **So, overprotective?**

  - Perhaps, if basis for standard is attainment of MMI

  - And, given potential for conflicting results
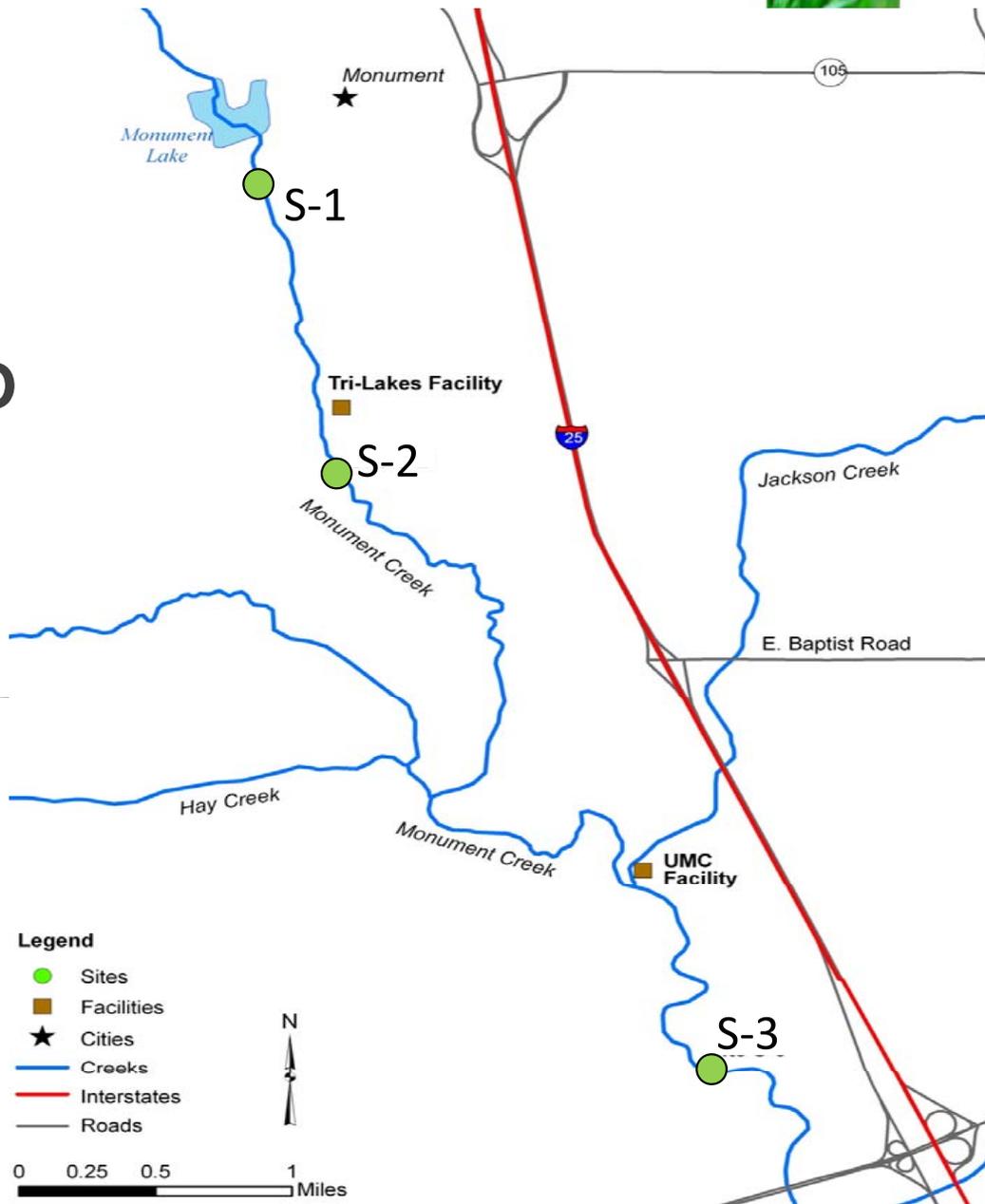
- **Alternative approach**

  - Extending the quantile regression line out to the MMI attainment threshold

  - Accounts for confounding factors
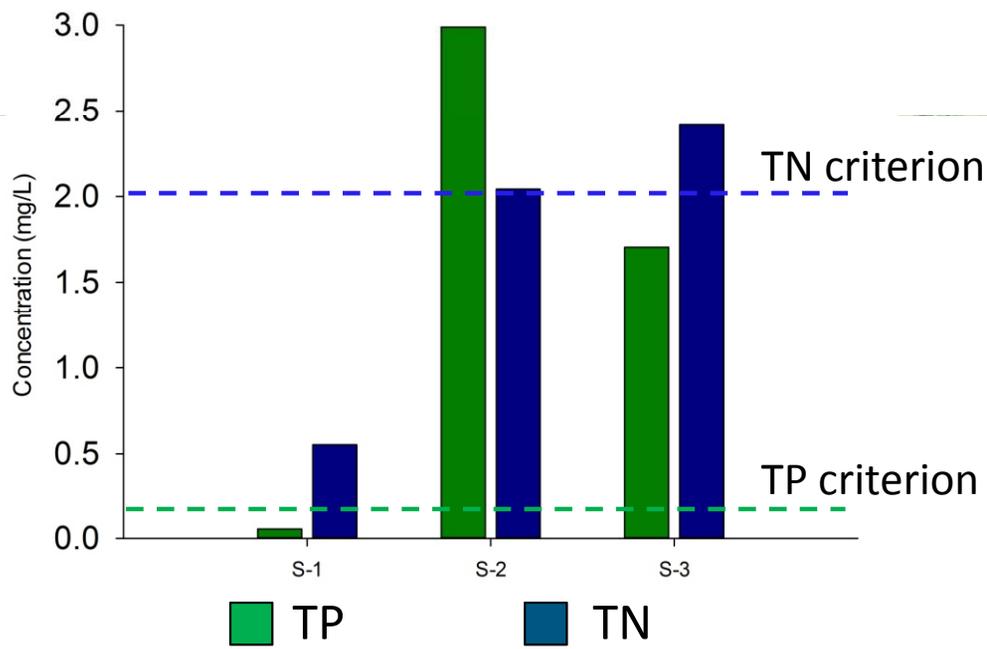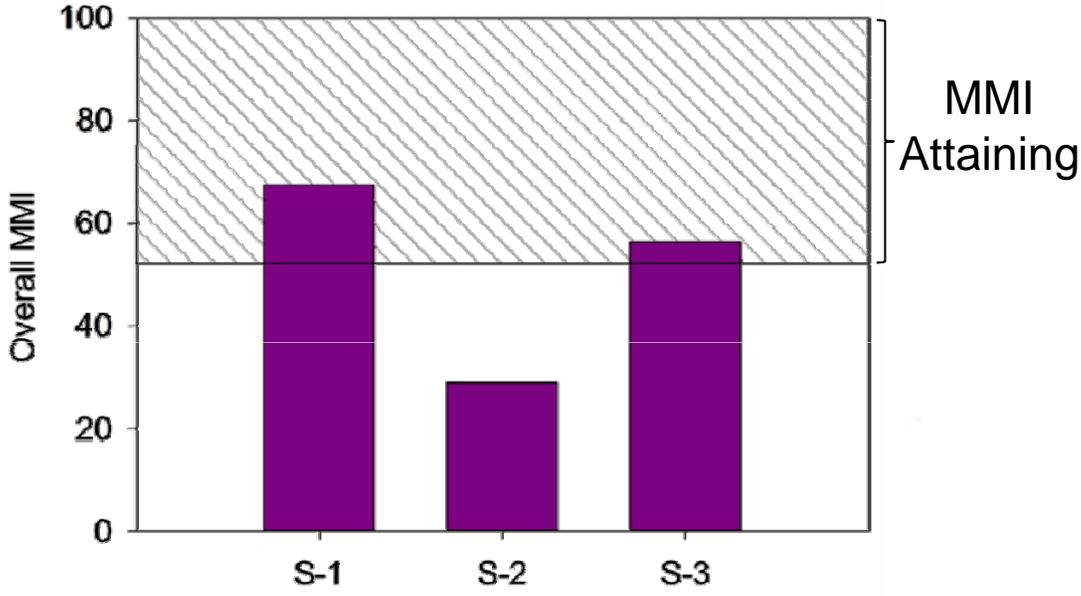
  - But, underprotective ?

Example: Monument Creek, Colorado

- **Nutrient and macroinvertebrate relationships assessed in Monument Creek, CO**

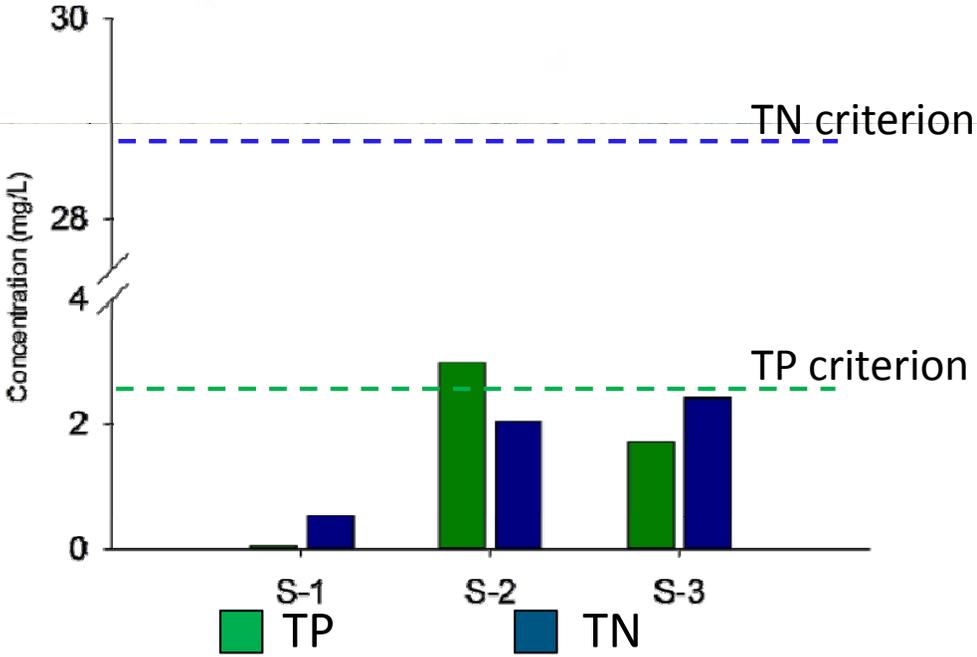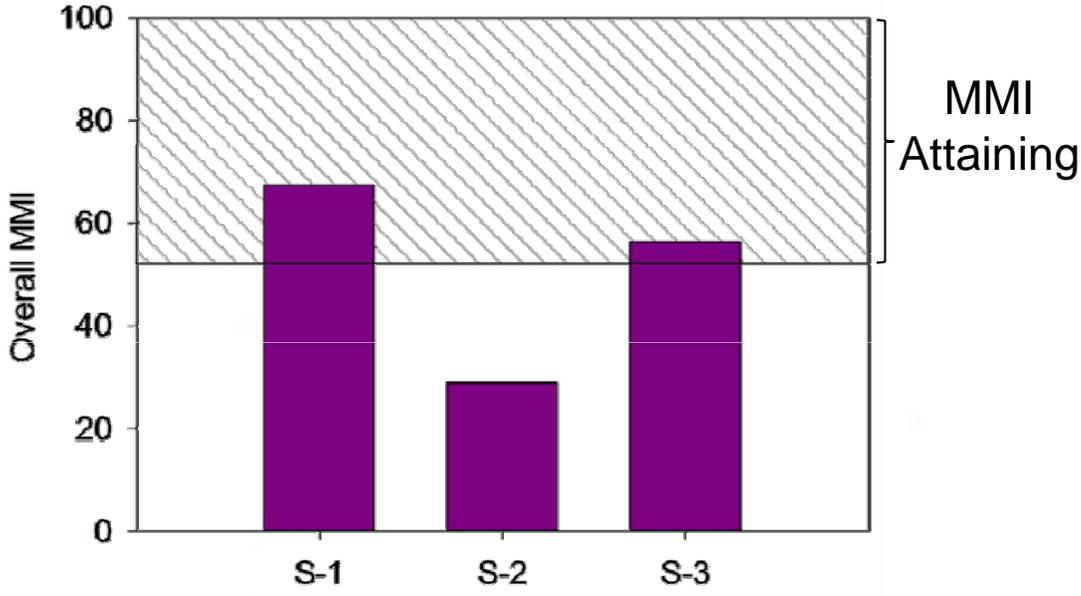- **Assessed using Colorado approach and alternative approach**

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Example: Monument Creek, Colorado

Site	TP/TN	MMI
S-1	Attain	Attain
S-2	Impair	Impair
S-3	Impair	Attain

12

Example: Monument Creek, Colorado

| Site	TP/TN	MMI
S-1	Attain	Attain
S-2	Impair/ Attain	Impair
S-3	Attain	Attain

13

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

MMI Attaining   MMI Impaired   MMI Attaining

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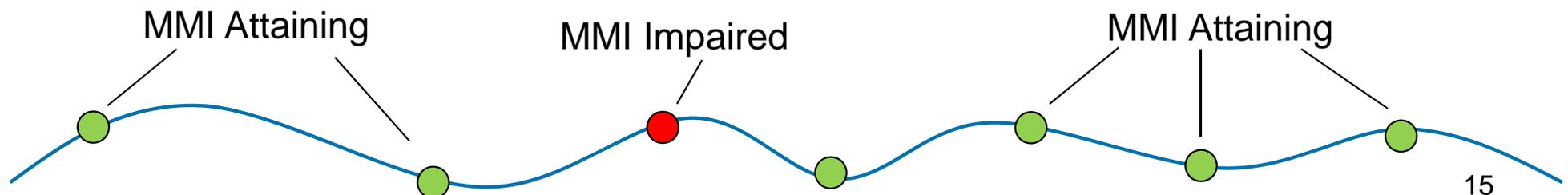
Discussion

- **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 area Attaining, but one is Impaired, should the segment be listed?

Questions?

Acknowledgements

Colorado Nutrient Coalition

Colorado Association of Commerce and Industry

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