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DEVELOPMENT OF DIAGNOSTIC TOOLS

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LTG 2 Poster 09

Science Question

What indicators, stressor measurements and remotely-sensed observations and watershed properties can be used to predict the likely sources of stressors and impairments?

How Research Addresses the Water Quality MYP Goals

Tools to support stressor identification (SI) weight-of-evidence approach

- diagnostic measures and tools to incorporate into states' biological and water quality monitoring programs

- tools to extract more information supporting causal analysis from existing monitoring data and compare systems

- methods for eliminating potential causes

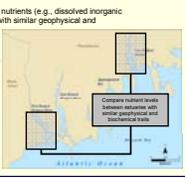
Research Objectives

- Develop and evaluate diagnostic tools for nutrients, suspended and bedded sediments, and toxic chemicals at multiple scales.
- Derive diagnostic community-level signatures specific to single stressors through meta-analysis of existing algal, macroinvertebrate, and fish community data collected by procedures used for 305(b) assessments, evaluating both sensitivity and specificity of indicators.
- Differentiate between variability due to differences in natural features among systems as compared to differences in stressor magnitude or pollutant loading.
- Compare effectiveness of diagnostic tools across systems (e.g., freshwater versus marine, lotic versus lentic).

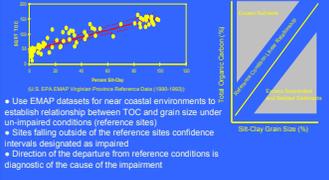
Develop and Evaluate Diagnostic Tools for Single Stressors: Toxic Chemicals, Suspended and Bedded Sediments, and Nutrients

Nutrients: Comparative Estuaries Approach

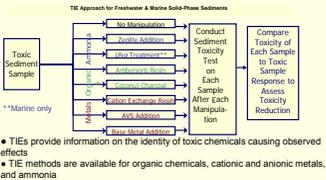
- Compare levels of primary nutrients (e.g., dissolved inorganic nitrogen (DIN)) in estuaries with similar geophysical and bioclimatic traits
 - tidal cycles
 - salinity regime
 - geographical orientation
- Levels of DIN in un-impaired estuaries will be less than concentrations in estuaries undergoing nutrient stress
 - This approach allows for diagnosing adverse nutrient effects at the system level



Suspended and Bedded Sediments: Grain Size Normalized Total Organic Carbon (TOC)

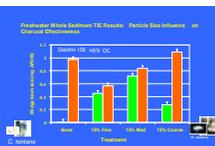
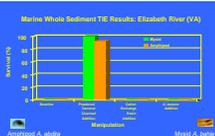


Toxic Chemicals: Perform whole sediment Toxicity Identification Evaluations (TIEs) on toxic freshwater & estuarine sediments



- TIEs provide information on the identity of toxic chemicals causing observed effects
- TIE methods are available for organic chemicals, cationic and anionic metals, and ammonia

Research Results - Examples



Interactions with Customers

Products

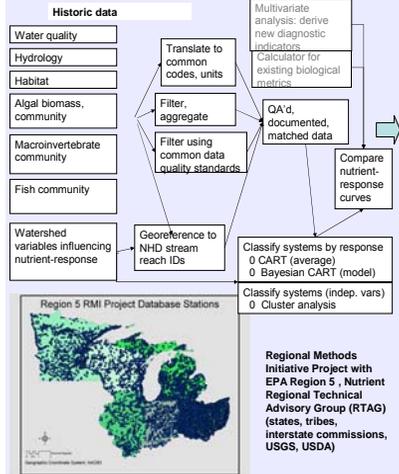
- Web distribution
 - RMI project outline (EPA Region 5 site)
 - EPA Guidance documents
 - Sediment TIE guidance (draft)
- Publications
 - Community diagnostic indicators
 - Estuarine causal analysis retrospective approach (draft)
- Analysis tools
 - Database tool for EPA Region 5 states
 - Queries for calculation of diagnostic indicators
 - Web SAS interface (with EPA OEI)
 - Methods workshop for EPA regions, Region 5 states/tribes, USGS, USDA
- Field validation
 - TIE evaluation of methods with Regional samples
- Principal Customers
 - Region 5 Regional Methods Initiative Project - (EPA Region 5, tribes, MN, WI, MI, OH, IL, IN)
 - Region 1: Narragansett Bay and New Bedford Harbor case studies (RI) (See poster LTG2-1)
 - Region 4: Pensacola Bay case study (FL)
 - RMI project (Regions 2, 6, 9): Use of TIEs in the TMDL process (NY/NJ, TX, CA)

Data Interpretation Tools for Community-Level Impairment

Research Methods & Collaboration

In collaboration with State, Regional, and local stakeholders, a suite of tools is being developed and tested at multiple scales for use in diagnosing or confirming some of the major causes of impairment in 303(d) listings (e.g., nutrients, suspended and bedded sediments, toxicity).

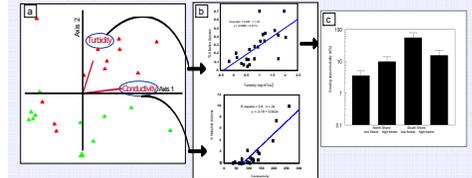
In addition to documenting the effectiveness of diagnostic tools in the literature, methods and guidance are being converted to user-friendly format to convey the States and Regions through web-based applications (including CADDIS), training workshops, and guidance documents.



Prototype for EPA Office of Environmental Information Regional web portal to regional database, mapping, and analytical tools

Example application of multivariate tools and diagnostic indicators to evaluation

- De-trended Correspondence Analysis on Lake Superior stream diatom communities identifies turbidity and conductivity as two important environmental variables associated with species distribution.
- Regression analyses evaluate the strength of the relationship between stressors and diatom community responses based on metrics derived from known species ecology.
- Turbidity was affected by a Region 10 mature forest interaction in the watershed experimental design, with highest values occurring in low mature forest watersheds on the South Shore. Results were consistent with effects on silt-tolerant diatoms.



Research Conclusions & Future Directions

- TIE: U.S. EPA TIE guidance document in preparation. These methods can be used to determine if toxic chemicals contribute to impairments.
- Comparative estuaries approach: Estuarine case studies are currently being used to evaluate effectiveness of this approach for diagnosing excess nutrients.
- Grain size normalized TOC: Reference site relationships, based on EMAP data sets, are being compiled for East and Gulf coast provinces. Following this exercise, analyses will begin assessing sites with anomalous grain size-TOC values as potentially diagnostic of impairments caused by suspended and bedded sediments.
- Further refinement and completion of the meta-analysis of historical database for EPA Region 5 streams and rivers for community-level indicators of nutrient impairment and incorporate queries to derive indicators into MS Access database structure for state and regional use. This database could also support development of diagnostic indicators for suspended and bedded sediments in streams and rivers.
- Evaluate existing and new benthic and fish community metrics compiled from R-EMAP, EMAP, and National Coastal Assessment databases for the Virginian Province for diagnostic potential. This work could be extended to data from estuaries in other marine provinces as well.

How Research Contributes to Outcomes

- Provide diagnostic tools for use by State and Regional water quality managers to conduct TMDLs
- Develop modules for use in CADDIS and augment Stressor Identification guidance (see poster LTG2-2)
- Case studies, Regional Methods projects and other field exercises provide opportunities to evaluate new diagnostic tools (see poster LTG2-01)